



HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

3440A

DIGITAL VOLTMETER



— CERTIFICATION —

THE HEWLETT-PACKARD COMPANY CERTIFIES
THAT THIS INSTRUMENT WAS THOROUGHLY
TESTED AND INSPECTED AND FOUND TO
MEET ITS PUBLISHED SPECIFICATIONS WHEN
IT WAS SHIPPED FROM THE FACTORY.

Ⓜ FURTHER CERTIFIES THAT ITS CALIBRATION
MEASUREMENTS ARE TRACEABLE TO THE
NATIONAL BUREAU OF STANDARDS TO THE
EXTENT ALLOWED BY THE BUREAU'S CALI-
BRATION FACILITY.



MANUAL CHANGES

MODEL

3440A

To adapt this manual for use with the instrument, make the following changes.

INSTRUMENT	PREFIX	SERIAL No.
3440A	439	

Amend Section VI

Replaceable parts to read:

**F1 2110-0001 Fuse: Cartridge 1.0 amp
250 V One Time**



OPERATING AND SERVICING MANUAL

MODEL 3440A

SERIALS PREFIXED 439-
WITH BACKDATING CHANGES.
PREFIXED 435-, 421-, 415-, 347-.

DIGITAL VOLTMETER

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Figure 1-1. Model 3440A Digital Voltmeter

Table 1-1a. Specifications (Basic Unit)

*Available Plug-in Units: Model 3441A Range Selector Model 3442A Automatic Range Selector Model 3443A High Gain/Auto Range Model 3444A DC Multi-Function Unit *3440A requires a plug-in to operate Sample Rate: 5 samples per second to 1 per 5 seconds with storage during samples and "Hold." In "Hold," a sample may be initiated by applying a +10-volt pulse 20 μs wide or greater (ac coupled), or by contact closure. DC Isolation: Signal common may be floated up to 500 volts dc from chassis ground. BCD Output: Output: 4-line BCD* (1-2-2-4) 6 columns consisting of 4 digits of data, polarity/function and decimal. *4-line BCD (1-2-4-8) available on special order. Impedance: 120K maximum, each line "0" state level: -24 volts "1" state level: -1 volt Reference Levels: Positive: approximately -2.5 volts, 330 ohms source impedance. Negative: approximately -27 volts, 920 ohms source impedance.	Print Command: Generated internally, hold-off level -12 vdc. Print level -2 vdc from 100 ohm source. Hold-off Requirements: Anywhere from +6 volts to +15 volts max. from source impedance less than 2000 ohms. (Provided by Φ562A Digital Recorder.) Power: 115 or 230 volts $\pm$10%, 50 to 1000 cps approximately 20 watts. Weight: Net, 18 lbs. (8 kg.); Shipping, 29 lbs. (13 kg.) Dimensions: 16-3/4" wide, 5-7/32" high, 13-1/4" deep (426 x 133 x 337 mm). Accessories Available: K01-3440A Plug-in Extender J74-562A/AR Digital Recorder for use with Φ3440A accepting 1-2-2-4 BCD code. (Floating Operation) Includes special printwheel, 6 BCD column boards, input connector assembly with cable. J75-562A/AR, same as J74-562A/AR except for single character function symbol.
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Table 1-1b. Specifications (with Φ Model 3441A Plug-in Unit)

Voltage Range: 4-digit presentation of 9.999, 99.99, and 999.9 volts fullscale with 5% over-range capability and overrange indication. Voltage Accuracy: $\pm 0.05\%$ of reading ± 1 digit including line voltage variations of $\pm 10\%$ from nominal. A front panel adjustment on the 3440A insures accuracy over the temperature range between $+15^{\circ}\text{C}$ and $+40^{\circ}\text{C}$ and $\pm 0.1\%$ ± 1 digit over the temperature range of 0°C to $+50^{\circ}\text{C}$. Voltmeter Input Impedance: Constant 10.2 meg-ohms (to dc) all ranges.	Input Filter AC Rejection: 10, 100, and 1000 volt ranges: 30 db at 60 cps, increasing at 12 db/octave. Input Filter Characteristics: Response Time: Less than 450 msec to a step function to within 99.95% of final value. Common Mode Rejection: <table><tr><th></th><th>10V Range</th><th>100V Range</th><th>1000V Range</th></tr><tr><td>DC</td><td>90 db</td><td>70 db</td><td>50 db</td></tr><tr><td>60~</td><td>70 db</td><td>50 db</td><td>30 db</td></tr></table> Range Selection: Manual Polarity: Automatic indication		10V Range	100V Range	1000V Range	DC	90 db	70 db	50 db	60~	70 db	50 db	30 db
	10V Range	100V Range	1000V Range										
DC	90 db	70 db	50 db										
60~	70 db	50 db	30 db										

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The Φ Model 3440A Digital Voltmeter displays positive or negative dc voltages to four significant figures from 0.001 volt to 999.9 volts. A Plug-in unit must be installed in the front panel compartment of the Model 3440A for measurements. Five Plug-in units are presently available for use with the Model 3440A.

1-3. INSTRUMENT DESCRIPTION.

1-4. The Model 3440A Digital Voltmeter is designed to measure dc voltages from 1 millivolt to 1000 volts with an accuracy of $\pm 0.05\% \pm 1$ count for operating temperatures between $+15^{\circ}\text{C}$ and $+40^{\circ}\text{C}$. Accuracy is maintained for overrange voltages of 5% on all ranges. Polarity is automatically indicated. A storage feature holds the last completed count on the front panel display while the next count is being totalized. Measurement sampling time is controlled by the front panel SAMPLE RATE control. Selection of range is controlled by the RANGE switch on the Plug-in unit (see paragraph 1-6). Mode of operation is also controlled by Plug-in controls.

1-5. Solid state components in the Model 3440A reduce the power consumption and internal heat dissipation, and increase instrument ruggedness. Nearly all circuit components are mounted on plug-in etched circuit boards, which provide a convenient method for substituting entire assemblies.

1-6. PLUG-IN UNITS.

1-7. A Plug-in unit is necessary for operation and is an integral part of the voltmeter circuit. Presently available Plug-ins are listed below. Table 1-2 is a comparison chart of the various Plug-ins.

- a. Φ Model 3441A Range Selector provides manual selection of 10, 100 and 1000 volt range.
- b. Φ Model 3442A Automatic Range Selector provides manual, automatic and remote selection of 10, 100 and 1000 volt range.
- c. Φ Model 3443A High/Gain Auto Range Unit provides manual, automatic and remote selection of 100 and 1000 millivolt; 10, 100 and 1000 volt range.

d. Φ Model 3444A DC Multi-Function Unit provides a manual ranging dc voltmeter, dc milliammeter and ohmmeter. Five ranges are provided for each function. (Full scale voltage ranges from 100 millivolts to 1000 volts; full scale current ranges from 100 microamperes to 1000 milliamperes; and full scale resistance ranges from 1000 ohms to 10 megohms.

e. Φ Model 3445A AC/DC Range Unit provides manual, automatic, and remote selection of 10, 100, and 1000 volt ranges for both ac and dc voltages.

1-8. Plug-in units that will further broaden the usefulness of the Model 3440A are in development. Contact your local Φ Field Office for more information.

1-9. INSTRUMENT DIFFERENCES.

1-10. Hewlett-Packard uses a two-section eight digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 3440A described in this manual.

1-11. If the first three digits of the serial number are prefixed with an E or a G, your instrument was produced in Europe. An E000-00000 serial number indicates that the instrument was manufactured in England; a G000-00000 serial number indicates that the instrument was manufactured in Germany.

1-12. MANUAL BACKDATING CHANGES.

1-13. A sheet that provides changes and serial prefix for all the Model 3440A's dating back to the first instrument produced, is given in Appendix C. The backdating sheet, when used with this manual, makes the manual applicable for all Model 3440A's produced.

1-14. SPECIAL INSTRUMENTS.

1-15. The Model 3440A is normally supplied with a 1-2-2-4 BCD code. Instruments with a 1-2-4-8 BCD code can be purchased on special order.

Table 1-2. Plug-in Function Chart

Φ PLUG IN	AC VOLTS 10V TO 1000V	DC VOLTS 10V TO 1000V	DC VOLTS 100 MV TO 1000V	DC AMPS	OHMS	MANUAL RANGING	AUTO RANGING	FLOATING INPUT	PRINTER OUTPUT	REMOTE RANGING	REMOTE TRIGGERING
3441A	*	✓				✓		✓	✓		✓
3442A	*	✓				✓	✓	✓	✓	✓	✓
3443A	*		✓			✓	✓	✓	✓	✓	✓
3444A	*		✓	✓	✓	✓		✓	✓		✓
3445A	✓	✓				✓	✓	✓	✓	✓	✓

* TRUE RMS VOLTAGE MEASUREMENTS: 1MV TO 300 VOLTS (10 CPS TO 10MC) USING THE Φ 34400A.

SECTION II

INSTALLATION

2-1. INCOMING INSPECTION.

2-2. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of marks or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage from transit. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in paragraph 5-3. If there is damage or a deficiency, see the warranty on the inside rear cover of this manual.

2-3. INSTALLATION.

2-4. Once the Plug-in unit has been installed in the Model 3440A, the instrument is ready for operation. Connect the power cable supplied with the instrument and check for proper power source and power cable requirements.

NOTE

If the Model 3443A High Gain/Auto Range Unit or the Model 3445A AC/DC Range Unit is used as a Plug-in and your Model 3440A has a serial number below 415-00726, make the modification given in paragraph 5-53. If your Model 3440A has a serial number below 347-00301, make the modification shown in paragraph 5-55.

2-5. POWER SOURCE REQUIREMENTS.

2-6. The Model 3440A can be operated from a 115 or 230 volt, 50 to 1000 cps ac source. Primary power requirements are set by the rear panel LINE VOLTAGE switch. Before plugging the Model 3440A into the power source, check that the designation on the two position LINE VOLTAGE switch matches the line voltage of your power source. The ac line fuse should be a 0.6 ampere, slow-blow type for both 115 and 230 volt modes of operation.

2-7. THREE CONDUCTOR POWER CABLE.

2-8. To protect operating personnel, National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 3440A is equipped with a detachable three-conductor power cable, which, when plugged into the proper receptacle, grounds the instrument. The round, offset pin on the power cable connector is the ground connection. To retain the protection feature when operating the instrument from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the adapter wire to a suitable ground.

2-9. RACK AND BENCH CONSIDERATIONS.

2-10. The Model 3440A Digital Voltmeter is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument. However, the Hewlett-Packard modular instrument enclosure system enables easy conversion from bench to rack model and vice versa. Instructions for the conversion are included with a kit shipped with the instrument and which includes the conversion hardware. The rack mount for the voltmeter is an EIA standard width of 19 inches. When rack mounted in a rack using mounting flanges, additional support at the rear of the instrument should be provided if vibration or similar stress is likely.

2-11. REPACKAGING FOR SHIPMENT.

2-12. The following is a general rule for repacking an instrument for shipment. If you have any questions contact your local Sales and Service Office (see maps in Appendix for location).

a. Place instrument in original container if available. If original container is not available, it can be purchased from your nearest Sales and Service Office.

If original container is not used,

b. Wrap instrument in heavy paper or plastic before placing in an inner container.

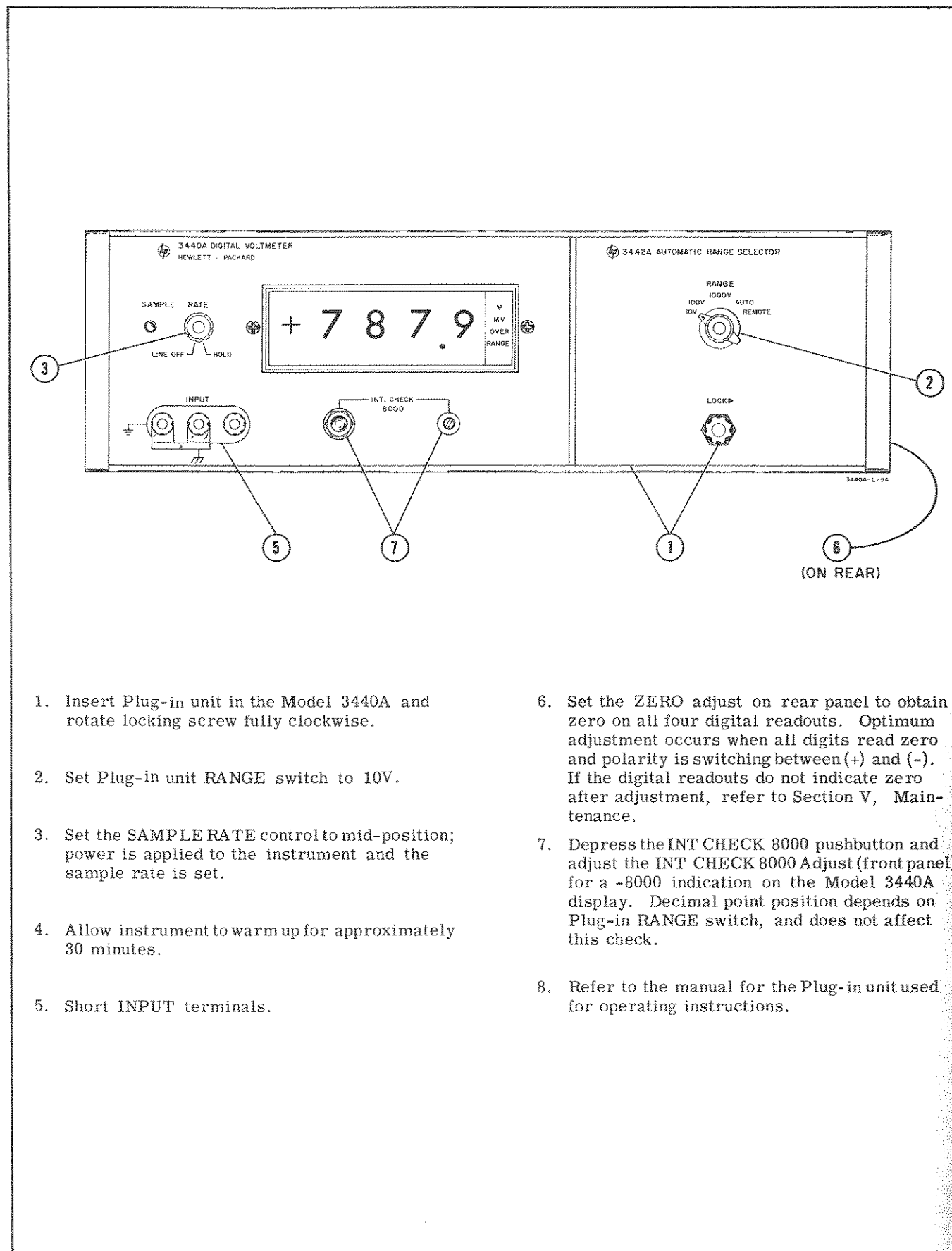
c. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.

d. Place instrument and inner container in heavy carton or wooden box and seal with strong tape or metal bands.

e. Mark shipping container with "Delicate Instrument, Fragile," etc.

NOTE

If instrument is to be shipped to Hewlett-Packard for service or repair, attach to the instrument a tag identifying the owner and indicate the service or repair to be accomplished; include the model number and full serial number of instrument. In any correspondence, identify the instrument by model number and serial number prefix.



1. Insert Plug-in unit in the Model 3440A and rotate locking screw fully clockwise.
2. Set Plug-in unit RANGE switch to 10V.
3. Set the SAMPLE RATE control to mid-position; power is applied to the instrument and the sample rate is set.
4. Allow instrument to warm up for approximately 30 minutes.
5. Short INPUT terminals.
6. Set the ZERO adjust on rear panel to obtain zero on all four digital readouts. Optimum adjustment occurs when all digits read zero and polarity is switching between (+) and (-). If the digital readouts do not indicate zero after adjustment, refer to Section V, Maintenance.
7. Depress the INT CHECK 8000 pushbutton and adjust the INT CHECK 8000 Adjust (front panel) for a -8000 indication on the Model 3440A display. Decimal point position depends on Plug-in RANGE switch, and does not affect this check.
8. Refer to the manual for the Plug-in unit used for operating instructions.

Figure 3-1. Turn On Procedure

SECTION III

OPERATING INSTRUCTIONS

3-1. GENERAL.

3-2. The Model 3440A Digital Voltmeter will measure dc voltages to four significant figures. Inputs can be sampled at rates ranging from 5 samples per second to 1 sample per 5 seconds. When used with the appropriate Plug-in unit, range selection can be remotely controlled. The Model 3440A is designed to provide output information to a Digital Recorder. (Refer to Plug-in manual for measurements other than dc voltages.)

3-3. FRONT AND REAR PANEL DESCRIPTION.

3-4. A description of front and rear panel and indicators is given in figure 3-2.

3-5. OPERATING INSTRUCTIONS.

3-6. Figure 3-2 shows turn on procedure. After initial turn on instructions have been performed, refer to the Plug-in manual for operating instructions.

3-7. OVERRANGE OPERATION.

3-8. The Model 3440A can be operated with input signals 5% overrange with no loss in accuracy giving five digit resolution at these points. The first significant figure will not be seen under these circumstances. For example, if the 10 volt range is selected and the input voltage is 10.500 volts, the front panel reading would be 0.500 volts and the OVERRANGE light will be lighted.

3-9. REMOTE CONTROL OF SAMPLE RATE AND RANGE SELECTION.

3-10. Sampling can be remotely controlled by placing SAMPLE RATE control in HOLD position. (1) Apply a +10 volt pulse at least 20 microseconds wide to pin 18 of the REMOTE CONTROL connector (J6) on rear panel; or (2) close a switch between pins 17 and 18 of the REMOTE CONTROL connector (J4). Mating connector for J4 is ϕ Stock No. 1251-0084.

3-11. Refer to the Plug-in manual for remote ranging procedure.

3-12. DIGITAL RECORDER OUTPUT.

3-13. The Model 3440A input information can be applied to a printer such as the ϕ Model 562A Digital Recorder at the DIGITAL RECORDER connector (J2) on the rear panel. The 562A-16C cable assembly included with the Model 562A is the mate to the DIGITAL RECORDER connector (J2). This mating connector has ϕ Stock No. 1251-0393. DIGITAL RECORDER connector (J2) is shown in figure 5-21.

NOTE

The DIGITAL RECORDER OUTPUT is referenced to the front panel input connector and may be either floating or chassis grounded, depending on shorting bar position.

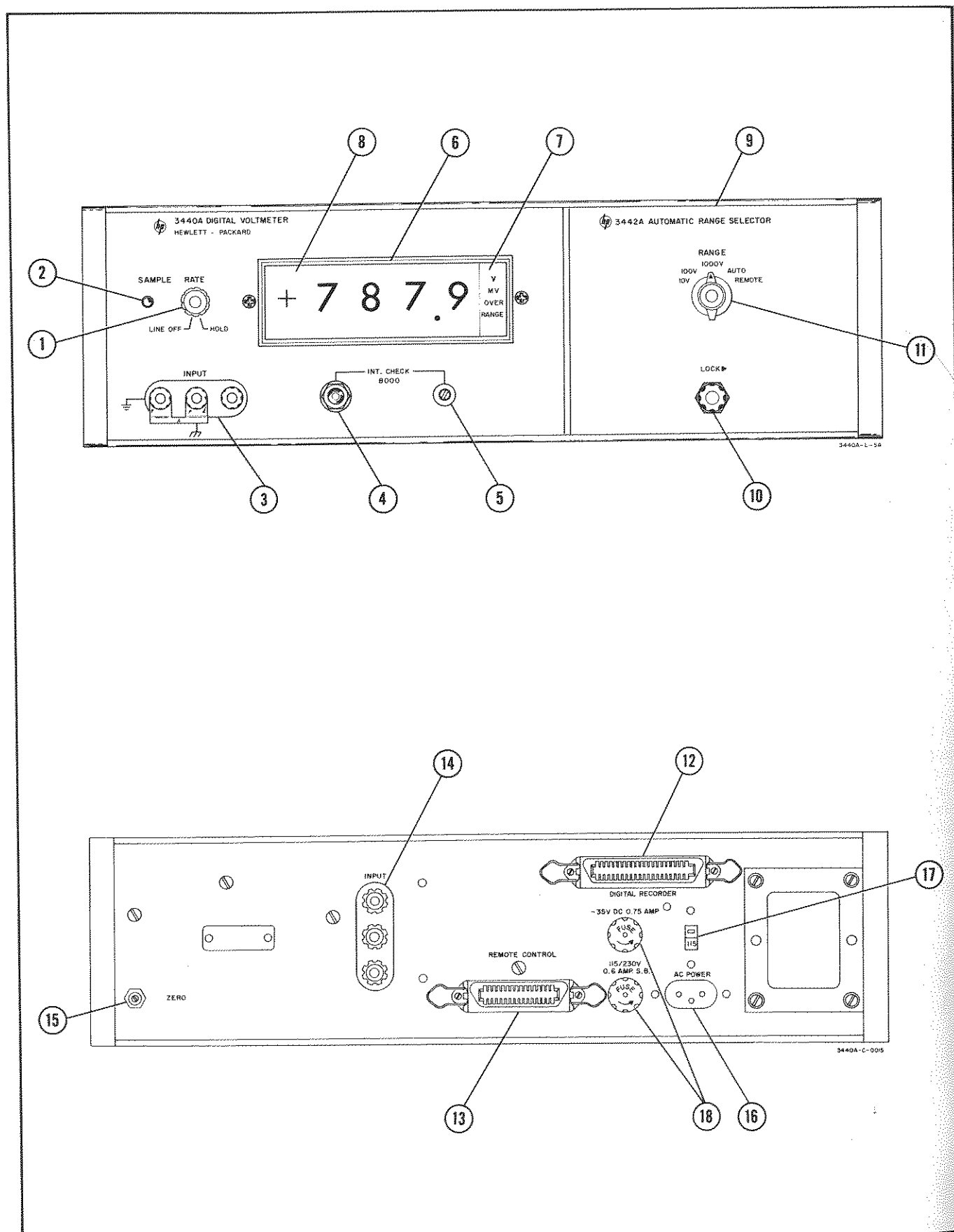


Figure 3-2. Front and Rear Panel Description

1. LINE and SAMPLE RATE control: Applies primary power to the instrument and varies the voltmeter sampling rate. Sample rate can be varied from 5 samples per second to 1 per 5 seconds or stopped in HOLD position.
2. SAMPLE RATE Indicator: Flashes at the Voltmeter measurement sampling rate.
3. INPUT: Input voltage is applied between the High (red) and Common (H) terminals. A shorting bar provided with the instrument allows the input signal to be referenced to chassis ground when connected between the instrument Common (H) and chassis ground (G) terminals.
4. INT CHECK 8000 Pushbutton: Depressing button applies -8.000 volts (with respect to voltmeter common) for calibration.
Set 15 for plot 5
5. INT CHECK 8000 Screwdriver Adjust: Adjust Model 3440A to internal voltage standard for -8000 display.
6. Illuminated Readout Display: Indicates input or calibrate voltage magnitude. Storage feature allows readout to be held during sampling, eliminating flickering of display.
7. Illuminated Operation Mode Indicator: Indicates instrument measurement units (V or MV) and OVERRANGE.
8. Polarity Indicator: Indicates input voltage polarity.
9. Plug-in Unit: Completes Model 3440A circuits and provides range and mode of operation selection.
10. Plug-in Unit Locking Screw: Tightens and locks Plug-in unit in place.
11. Plug-in Unit RANGE Switch: Sets maximum input to Model 3440A; controls decimal point and Function Light.
12. DIGITAL RECORDER: Supplies 3440A input information in binary coded decimal form to a Digital Recorder providing a printed record.
13. REMOTE CONTROL: Ranging information can be applied through this connector when an automatic ranging Plug-in unit is used. Sample rate information can be applied through this connector when any Plug-in unit is used.
14. INPUT: Connected electrically in parallel with the front panel INPUT connector.
15. ZERO: Sets the four digital readouts on the front panel for a zero indication.
16. AC POWER: Connects to the primary power cable supplied with the instrument.
17. AC VOLTAGE: Sets the Model 3440A for either 115 or 230 volt operation.
18. -35 VDC and 115/230 Volt Fuse: The -35 vdc fuse is a 0.75 ampere fuse; the 115/230 volt fuse is a 0.6 ampere slo-blo fuse.

Figure 3-2. Front and Rear-Panel Description (cont'd)

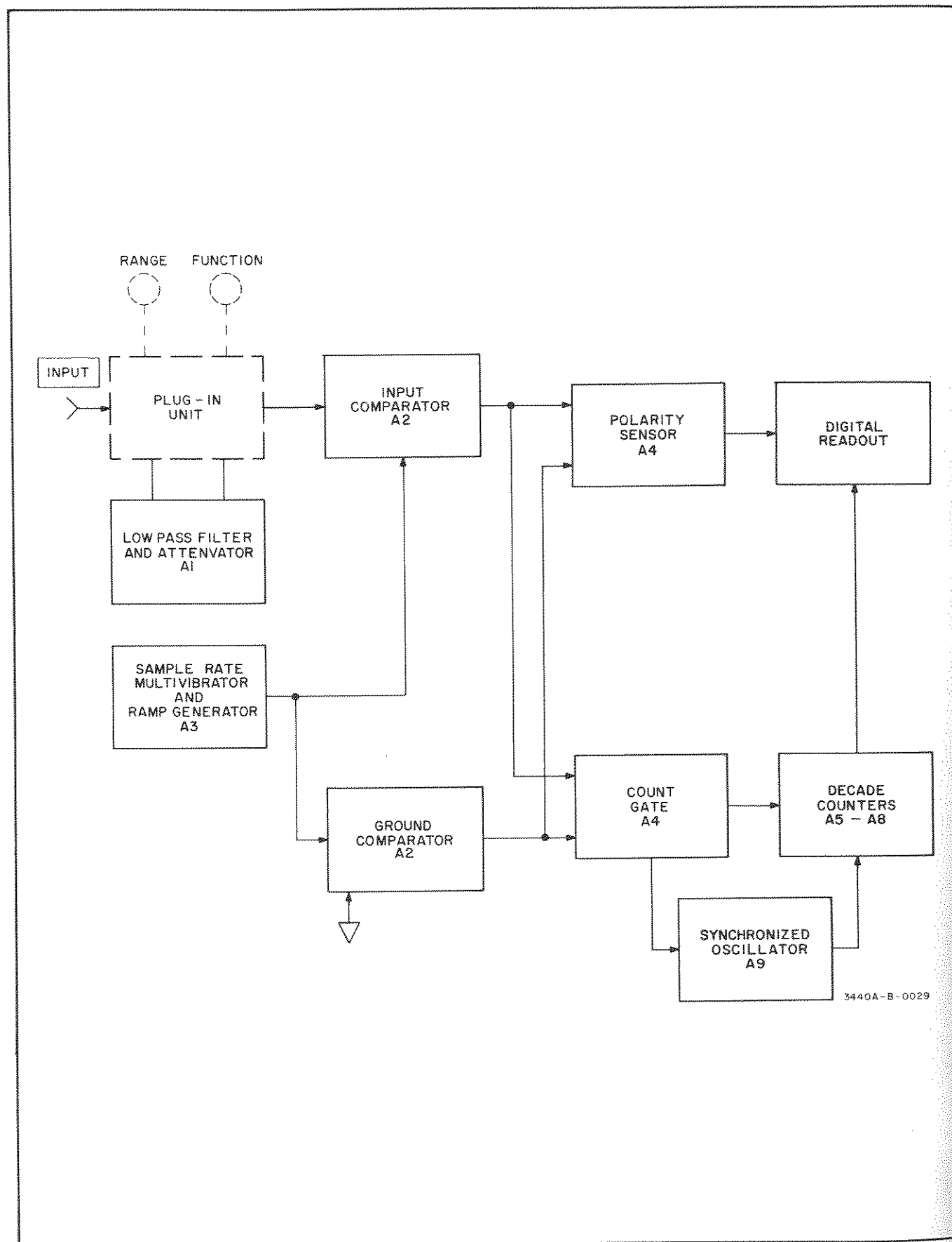


Figure 4-1. Simplified Block Diagram

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. The measurement technique used in the Model 3440A is a sampling process. During each sample the input voltage is compared with a very linear internally generated ramp voltage, producing a pulse upon coincidence. The reference (ground) is also compared with the ramp voltage producing another pulse. The time interval between these two pulses is measured and displayed on the front panel readout. Polarity is automatically indicated by the order in which these pulses are generated.

4-3. Refer to Figure 4-1, Simplified Block Diagram, and Figure 4-3, Detailed Block Diagram, for a description of the Model 3440A operation.

4-4. The input signal is applied to the Plug-in unit. Depending on the position of the Plug-in unit FUNCTION and RANGE switches, this signal is either modified by the Plug-in unit or applied to the Low Pass Filter and Attenuator A1. From the Low Pass Filter and Attenuator, the signal is returned to the Plug-in unit RANGE switch which selects the proper range and applies the signal to the Input Comparator A2. (Refer to Plug-in manual for discussion of the plug-in unit function.)

4-5. The Input Comparator A2 compares the input dc voltage from the Plug-in unit with a very linear internally generated ramp voltage. A pulse is produced

when the ramp reaches the same level as the input voltage. Another pulse is produced when the ramp passes through zero (ground). These two pulses are applied to the Polarity Sensor and Count Gate A4. The Polarity Sensor lights the proper sign on the front panel display. The Count Gate controls the 400 kc Synchronized Oscillator A9 and the Decade Counters (A5 - A8). During the time interval between the two comparator pulses, the decade counters totalize the oscillator pulses and present this information on the front panel display. A storage feature permits the last completed count to be held on the front panel display while the next count is being totalized. This feature prevents the readout display from flickering during the counting process.

4-6. LOGIC SYMBOLOGY.

4-7. Some of the circuits in the Model 3440A are explained in terms of logic symbology (AND Gates, OR Gates, etc). All the basic information required to understand the logic symbology and circuits discussed in this section is given in Table 4-2.

4-8. The Model 3440A uses positive true logic unless otherwise noted. A zero or false state is approximately -15 to -35 volts (relatively negative). A one or true state is approximately 0 to -2 volts (relatively positive) unless otherwise noted.

Table 4-1. Timing Sequence

Time	Description	Circuit Action
T_0 (0 msec)	Reset	Beginning of Sample Voltage Comparator Reset Ramp started Decade Counters Reset Transfer inhibited
T_1 (4 to 56 msec)	Input Voltage Comparison	Ramp Voltage equal to Input Voltage Count Gate opened if Input Voltage positive Count Gate closed if Input Voltage negative
T_G (30 msec)	Reference Comparison	Ramp Voltage Zero Count Gate opened if Input Voltage negative Count Gate closed if Input Voltage positive
T_2 (60 msec)	End of Ramp	End of Ramp Sample Rate Multivibrator reset Transfer enabled Print Command generated
T_3 (85 msec)	Recovery	Ramp Capacitor recharged Ready for new sample

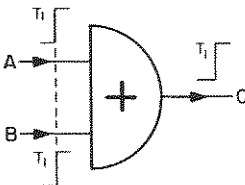
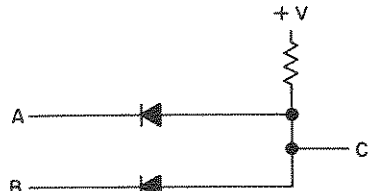
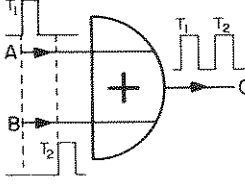
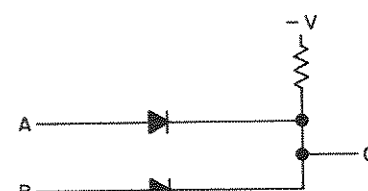
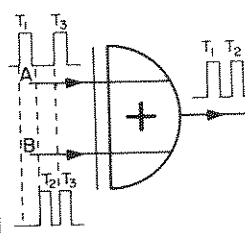
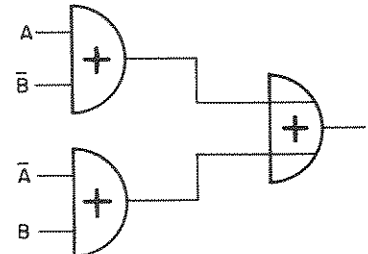
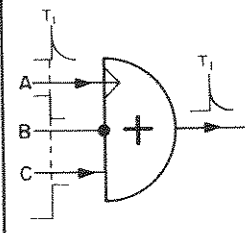
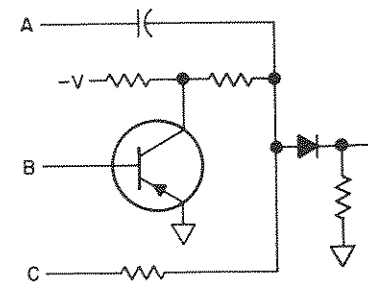
LOGIC SYMBOLS																																								
+ within a symbol indicates positive true logic - within a symbol indicates negative true logic 1 indicates true signal 0 indicates false signal		— on symbol indicates dc coupling — on symbol indicates ac coupling — on symbol indicates logical inversion (not necessarily electrical) — indicates direction of signal flow																																						
Desig.	Logic Symbol	Description	Truth Table	Equivalent Circuit																																				
AND Gate		Both input signals (A and B) must be true simultaneously to produce a true output at C.	<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>	A	B	C	0	0	0	0	1	0	1	0	0	1	1	1																						
A	B	C																																						
0	0	0																																						
0	1	0																																						
1	0	0																																						
1	1	1																																						
OR Gate		If either input signal (A or B) or both is true, the output at C is true. (A positive OR Gate is electrically equivalent to a negative AND Gate only when dc coupling is used.)	<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>	A	B	C	0	0	0	0	1	1	1	0	1	1	1	1																						
A	B	C																																						
0	0	0																																						
0	1	1																																						
1	0	1																																						
1	1	1																																						
Exclusive OR Gate		If either input signal (A or B), but not both, is true, the output at C is true.	<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	A	B	C	0	0	0	0	1	1	1	0	1	1	1	0																						
A	B	C																																						
0	0	0																																						
0	1	1																																						
1	0	1																																						
1	1	0																																						
Multiple Input Gate		Any combinations of inputs may be used with an AND or OR Gate to obtain a desired output. In the AND Gate shown, input A is ac coupled, input B is dc coupled and inverted, and input C is dc coupled without inversion. Inputs A and C must both be true, and input B must be false simultaneously to produce a true output at D.	<table><tr><th>A</th><th>B</th><th>C</th><th>D</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td></tr></table>	A	B	C	D	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0	0	1	0	1	1	1	1	0	0	1	1	1	0	
A	B	C	D																																					
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Table 4-2. Explanation of Logic Symbology

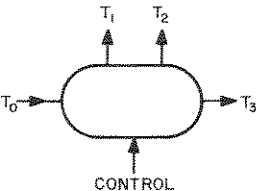
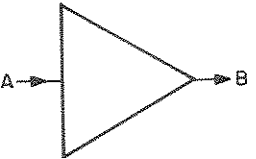
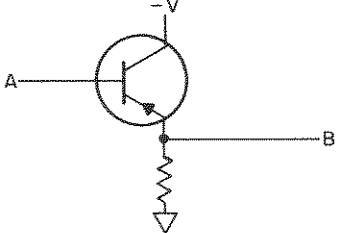
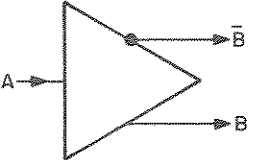
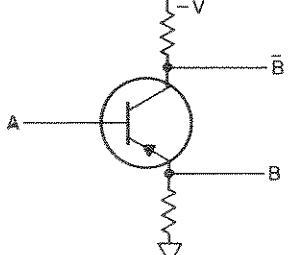
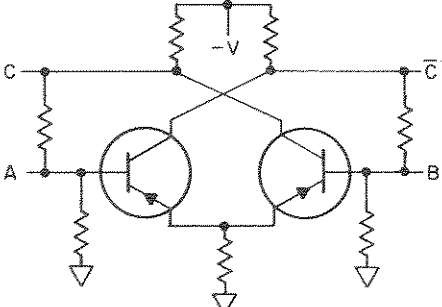
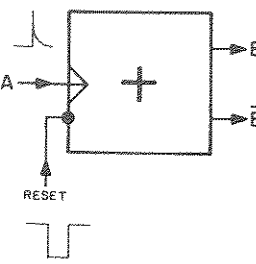
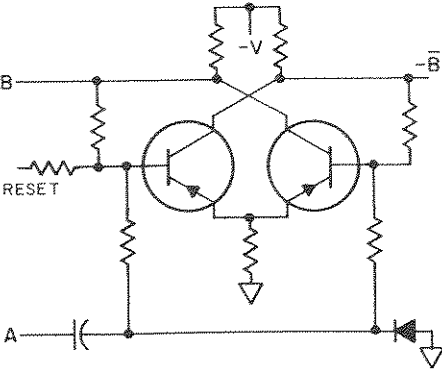
Desig.	Logic Symbol	LOGIC SYMBOLS Description	Equivalent Circuit
Passive Delay		Amount of delay depends on RC or RL time const.	RC or RL coupling
Amplifier		True input at A produces amplified true output at B. An amplifier will function with either positive true or negative true signals.	
Phase Splitter		True input at A produces true output at B and false output at $\bar{B}$ (read as "B bar" or "B not").	
Flip-Flop		Outputs C and $\bar{C}$ are always in opposite states -- if C is true $\bar{C}$ is false. A true input will cause the input directly across to go true -- true input at A sets output C true. With no input the flip-flop remains in the state set by the last input signal. The flip-flop is considered to be in the zero state if output C is false.	
Binary		The binary is a flip-flop which changes state with every true input pulse at A. Since A is applied to the bases of both transistors, it is shown centered in the symbol. The negative pulse produces the same effect as a positive pulse applied to the opposite base. To preserve the positive logic, the reset pulse is shown inverted and applied to the opposite side.	

Table 4-2 Explanation of Logic Symbology

4-9. TIMING.

ramp capacitor begins to discharge. A3QCR1A, A3Q15, and A3Q16 form a current amplifier to increase the linearity of the ramp. Transistor A3Q17 acts as a current source to insure proper bias for breakdown diode A3QCR1B.

4-11. CONTROL CIRCUITS.

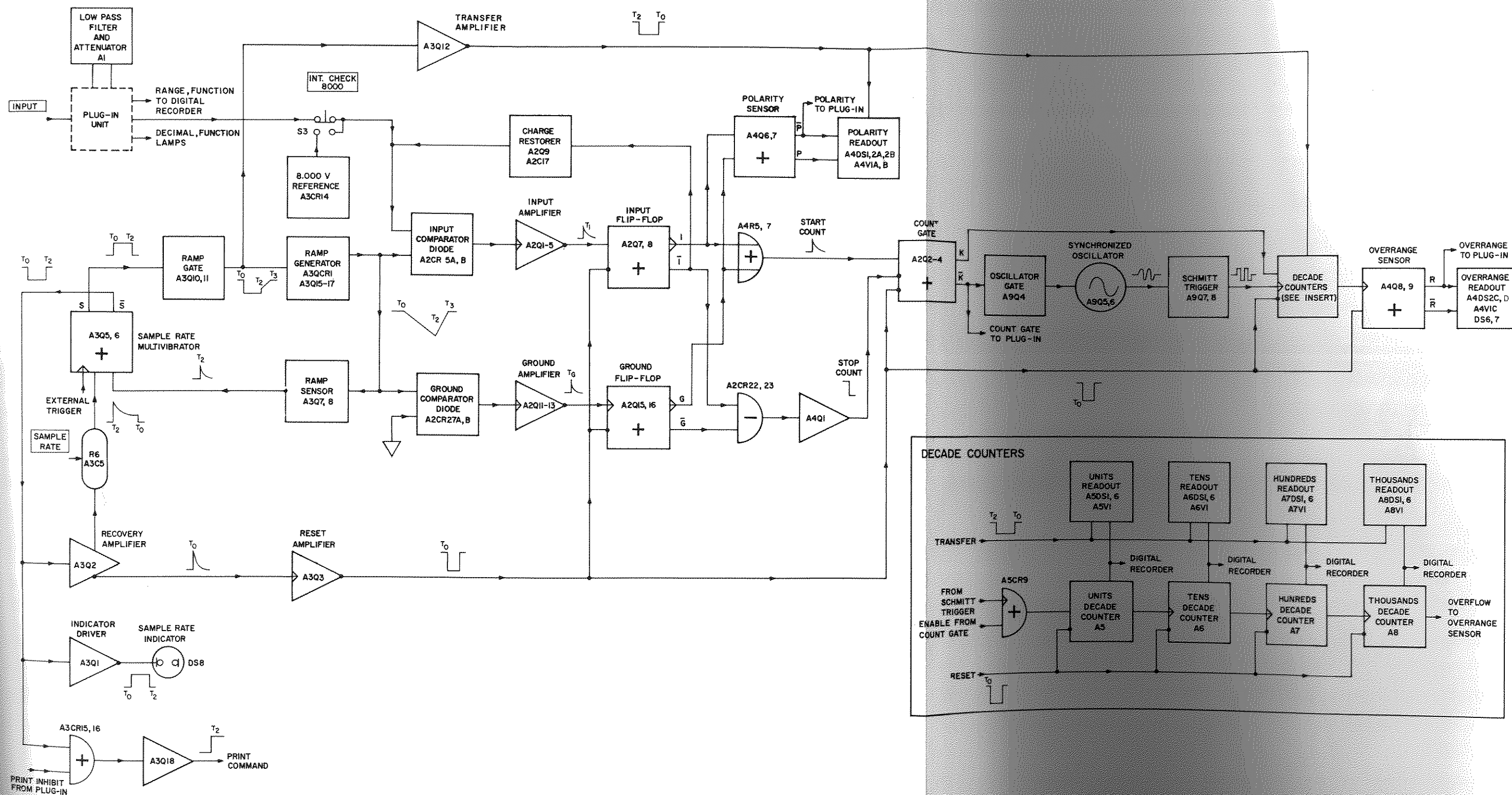
4-12. RAMP GENERATOR.

4-15. When the ramp reaches -12 volts, time T_2 occurs, and the Ramp Sensor (A3Q7, 8) applies a positive pulse to the Sample Rate Multivibrator causing S to go false ending the sample.

4-16. When S is false, the RampGate forward biases A3CR11 recharging the ramp capacitor toward +12 volts. When the ramp capacitor is fully charged, time T_3 occurs, and the Model 3440A is ready for another sample.

4-17. Breakdown diode A3QCR1B establishes a second ramp identical in slope, but at a level 6.6 volts more negative than the first ramp providing a constant current to the Input Comparator (refer to paragraph 4-41).





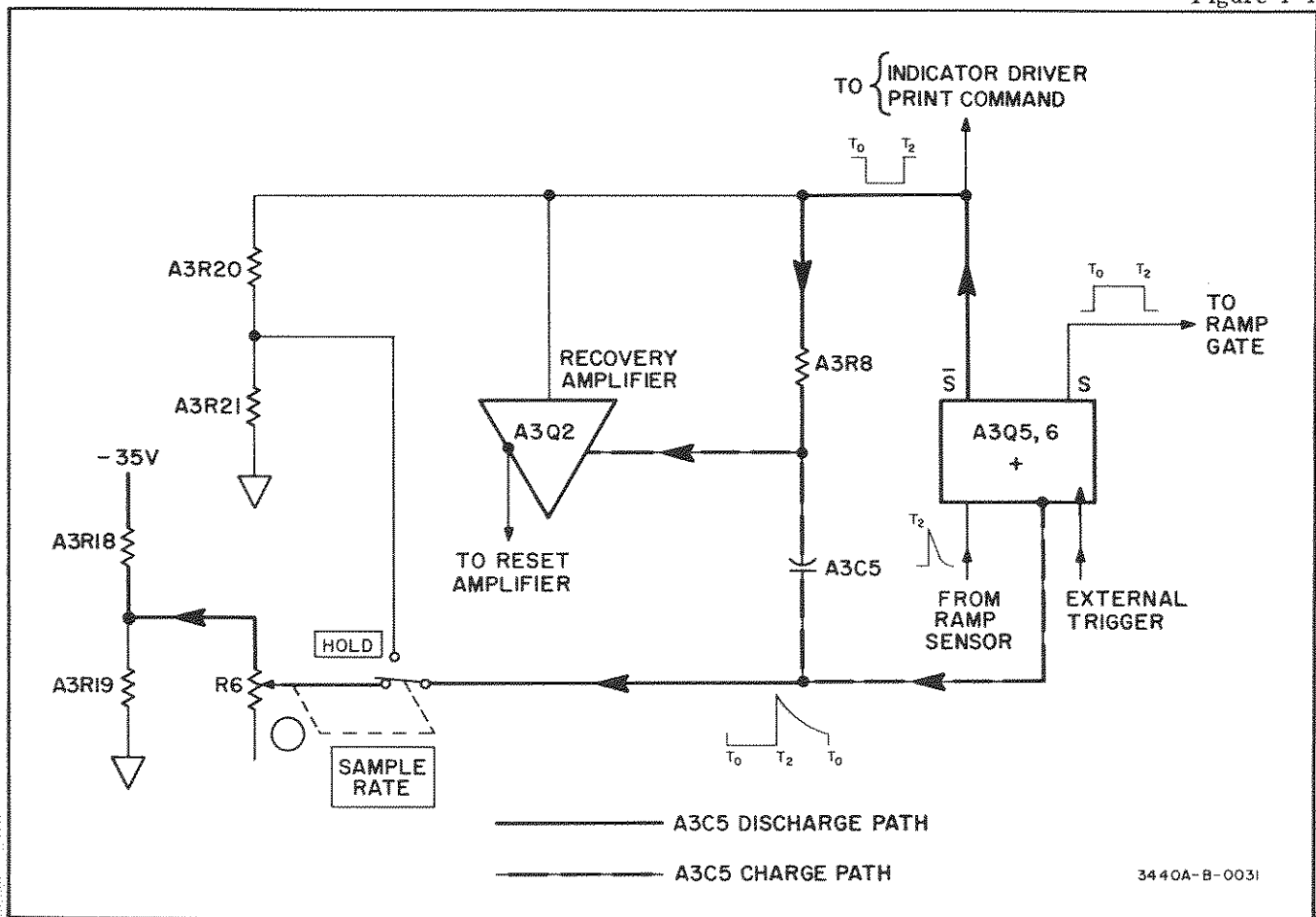


Figure 4-4. Sample Rate Multivibrator

4-18. SAMPLE RATE MULTIVIBRATOR.

4-19. The Sample Rate Multivibrator (Figure 4-4) controls sampling rate, Ramp Gate, Reset Pulse and Print Command. (Refer to paragraphs 4-18 through 4-32 for discussion of these circuits.)

4-20. When the Model 3440A is not sampling, the Sample Rate Multivibrator output $\bar{S}$ (read as "S bar" or "S Not") is true. A3C5 then begins to discharge through A3R18, R6, and A3R8. When A3C5 discharges sufficiently, output $\bar{S}$ goes false. At this point, time T_0 occurs and a sample is started. When the ramp voltage reaches -12 volts, time T_2 occurs, and a positive pulse from the Ramp Sensor causes $\bar{S}$ to go true, ending the sample. SAMPLE RATE control R6 changes the discharge time of A3C5, allowing a variation in sample rate from 5 samples per second to 1 sample per 5 seconds.

4-21. When SAMPLE RATE control is in HOLD position (maximum clockwise) A3C5 is held at a slightly negative voltage by voltage divider A3R20 and A3R21, which keeps output $\bar{S}$ true preventing a sample. Under these conditions, applying a positive going pulse to the External Trigger sets $\bar{S}$ false initiating one sample.

4-22. At time T_0 , Recovery Amplifier A3Q2 is turned on by $\bar{S}$, quickly recharging A3C5.

4-23. During a sample, Indicator Driver A3Q1 is turned off by $\bar{S}$ causing SAMPLE RATE indicator DS8 to light.

4-24. RESET PULSE.

4-25. The negative Reset pulse is generated at time T_0 by Reset Amplifier A3Q3. The Reset pulse is applied to the Plug-in unit, Voltage Comparator A2, Count Gate A4, Decade Counter Assemblies (A5 - A8), and Overrange Sensor A4. This negative Reset pulse prepares these circuits for the start of the next sample by setting them to the zero state.

4-26. At time T_0 , A3Q2 is switched to the one state. This positive going transition is differentiated and applied to the Reset Amplifier A3Q3. This differentiated pulse quickly drives A3Q3 into saturation and back to cut off. Thus, a short duration (approximately 20 microseconds) negative reset pulse is generated at time T_0 .

4-27. TRANSFER PULSE.

4-28. The Transfer pulse is used to transfer the count contained in the Decade Counters (A5 - A8) to the front panel display. This transfer is accomplished at time

T_2 after the decade counters have completed the count. This prevents flickering of the front panel display.

4-29. At time T_2 , Sample Rate Multivibrator output S goes false. This signal is inverted by Ramp Gate (A3Q10, 11) which sets the Transfer Amplifier A3Q12 output false. The data contained in the decade counters is then transferred to the front panel display. At time T_0 , output S goes true, causing the Ramp Gate to set the Transfer Amplifier output true, preventing the further transfer of data to the front panel display. (Refer to paragraphs 4-64 through 4-66 for discussion of count storage.)

4-30. PRINT COMMAND.

4-31. At the end of a sample, time T_2 , the Print Command is generated to actuate a digital recorder. A signal from the Plug-in unit will inhibit this command preventing a printout during an automatic range change (refer to Plug-in manual for description).

4-32. At time T_2 , Sample Rate Multivibrator output $\bar{S}$ goes true, and is direct coupled to the Print Command AND Gate. Normally, the Print Inhibit line from the Plug-in is in the one state allowing the level from $\bar{S}$ through AND Gate. This pulse is amplified by A3Q18 producing the Print Command. If the Plug-in is automatically changing range, the Print Inhibit line is in the zero state preventing the Print Command.

4-33. INPUT CIRCUITRY.

4-34. This section will discuss only the 10, 100 and 1000 volt dc ranges. For discussion of other ranges and functions, refer to the appropriate Plug-in manual.

4-35. LOW PASS FILTER AND ATTENUATOR.

4-36. The input signal is sent through the Plug-in unit to the Low Pass Filter and Input Attenuator A1. The Input Attenuator resistance and capacitance along with Input Comparator A2 capacitance form an rc filter which rejects ac voltages 30 db or more at 60 cps. The three attenuator outputs (one for each of the three ranges -- 10, 100, and 1000 volts) are returned to the RANGE switch in the Plug-in unit, which selects the proper amount of attenuation and Model 3440A decimal point position. The attenuated voltage is applied to the voltage comparator A2.

4-37. INTERNAL CALIBRATION.

4-38. The Reference 8000 circuit provides an accurate reference for internal calibration of the Model 3440A. This calibration voltage is supplied from breakdown diode A3CR14 through a precision voltage divider to the INT CHECK 8000 pushbutton switch S3. When this switch is depressed, -8.000 volts is applied to the Input Comparator A2, and the INT CHECK 8000 Adjust R3 (in Ramp Generator) is adjusted for a front panel

display of -8000 to insure that the Model 3440A is within specifications.

NOTE

Plug-in controls do not affect this check.

4-39. VOLTAGE COMPARATOR.

4-40. The voltage comparator produces two pulses. One is produced by coincidence between input voltage and the ramp; the other by coincidence between the reference (ground) and the ramp. The time interval between these two pulses is directly proportional to the input voltage.

4-41. INPUT COMPARATOR.

4-42. The Input Comparator (Figure 4-5) compares the input dc voltage from the plug-in unit with the ramp voltage. A diode pair (A2CR5A and A2CR5B) is the heart of this comparing action. The ramp, which begins at +12 volts and ends at -12 volts, is applied to the anode of A2CR5A. The input dc voltage is applied through A2R12 to the anode of A2CR5B. A second ramp, identical in slope, but 6.6 volts more negative than the first, is applied through A2R2 to the cathode of A2CR5. This supplies a constant current to A2CR5A. When the ramp voltage decreases to the level of the input dc voltage, time T_1 occurs, and A2CR5B conducts producing a current pulse which is amplified by the Input Amplifier (A2Q1 - 5). This amplified positive going pulse sets Input flip-flop to the one state. Output I is differentiated and applied to the OR Gate and the Polarity Sensor A4. Output $\bar{I}$ is applied to the AND Gate (negative true logic) and the Charge Restorer Switch A2Q9. When $\bar{I}$ goes false, A2Q9 is saturated and the positive going transition at its collector is applied through A2CR7 to back bias the Input Comparator Diode pair A2CR5.

4-43. CHARGE RESTORER.

4-44. During the input voltage comparison, a portion of the charge on A2C4 produces the Input Pulse. The Charge Restorer circuit (see Figure 4-6) replaces this charge. As a result, the input signal does not have to supply the charge and the high input impedance of the Model 3440A is maintained.

4-45. Between times T_0 and T_1 , -35 volts through A2Q9 forward biases A2CR17 and reverse biases A2CR16. A2CR15 is forward biased and A2CR10 is reverse biased through A2R28. A2CR10 has a very low leakage current preserving the high input impedance of the Model 3440A. Two taps on the voltage divider A2R38 to A2R41 charge A2C17 through forward biased diodes A2CR15 and A2CR17. At time T_1 , the moment of input voltage comparison, A2Q9 collector is switched to +12 volts. This reverse biases A2CR15, A2CR17 and forward biases A2CR16 and A2CR10, clamping A2C17 to the ramp voltage, which at this moment is equal to the input voltage. The charge on A2C17 is then driven through A2R19 and A2CR10 to A2C4, thus restoring the charge used for comparison.

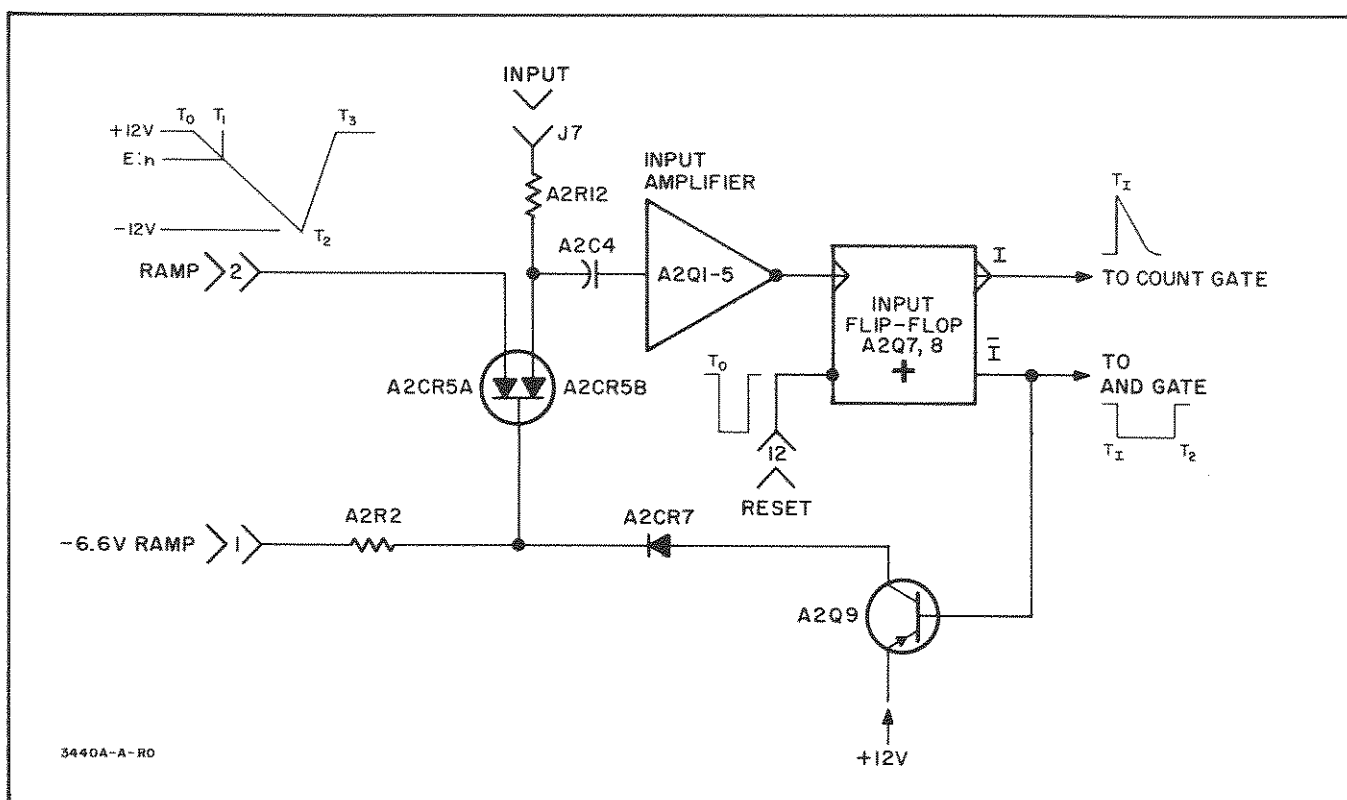


Figure 4-5. Input Comparator

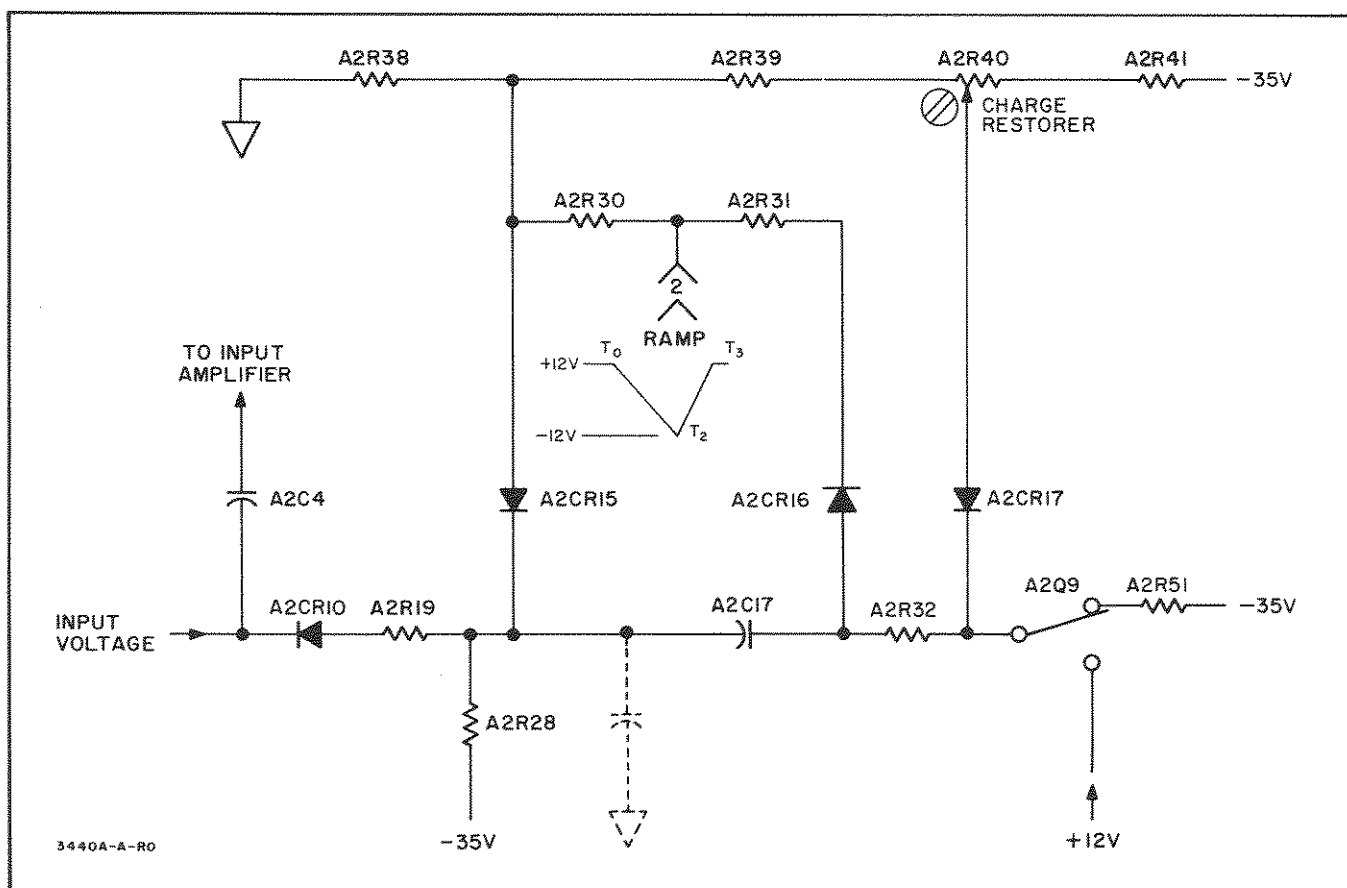
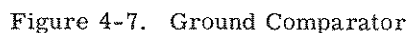
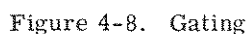


Figure 4-6. Charge Restorer



parator (see Figure 4-7). The ramp voltage is applied to the anode of A2CR27A causing this diode to conduct. When the ramp passes through zero (ground) time T_G occurs, and A2CR27B conducts producing a current pulse which is amplified by Ground Amplifier (A2Q11 - 13). This amplified positive pulse sets Ground flip-flop to the one state. Output G is differentiated and applied to the OR Gate and Polarity Sensor A4. Output $\bar{G}$ is applied to the AND Gate (negative true logic). When G goes true, this positive going transition is applied through A2CR28 to back bias the diode pair A2CR27B.



4-49. GATE AND COUNT CIRCUITS.**4-50. POLARITY SENSOR.**

4-51. Both true Voltage Comparator pulses (I and G) are applied to the Polarity Sensor A4Q6, 7. This flip-flop remains in the state set by the last of these two pulses. At time T_2 , the Transfer Pulse goes false allowing the proper sign to light on the front panel display. (Refer to paragraphs 4-64 through 4-66 for discussion of storage.)

4-52. GATING.

4-53. The function of the gating circuits (see figure 4-8) is to:

- Generate the gating signal which starts and stops the Synchronized Oscillator A9.
- Enable and inhibit the Units Decade Counter A5.
- Supply the Plug-in unit with Count Gate pulse (refer to the Plug-in manual for discussion of Count Gate as pertaining to the Plug-in unit).

4-54. At time T_0 , the Reset pulse is applied to the Count Gate to insure it is in the zero state.

4-55. At time T_I or T_G , whichever occurs first, a positive going spike from the OR Gate sets output $\bar{K}$ false. Output $\bar{K}$ turns on the Synchronized Oscillator A9, while output K enables the Decade Counters (A5 - A8) to totalize the oscillator pulses.

NOTE

Output K, which enables and inhibits

the Decade Counters, is a gating current. No significant voltage change can be observed.

4-56. At time T_I or T_G , whichever occurs last, a negative going pulse from the AND Gate Amplifier sets output $\bar{K}$ true turning off the Synchronized Oscillator and inhibiting the Decade Counter.

4-57. SYNCHRONIZED OSCILLATOR.

4-58. Count Gate output $\bar{K}$ is applied to the Oscillator Gate A9Q4. When $\bar{K}$ goes false (at time T_I or T_G , whichever is first) A9Q4 quickly turns on the 400 kc synchronized oscillator. A9Q4 fixes the phase relationship between the Count Gate and the oscillator preventing a ± 1 count ambiguity. This oscillator A9Q5 is a Colpitts type with emitter follower A9Q6 as an isolation amplifier.

4-59. The Schmitt Trigger A9Q7, 8) is a regenerative bistable circuit whose state depends on the amplitude of the input voltage. This circuit produces pulses with a very fast rise and fall time. The output pulses are applied to the Decade Counters (A5 - A8) to be totalized.

4-60. DECADE COUNTERS.

4-61. The four Decade Counters (A5 - A8) totalize the oscillator pulses to provide the front panel readout and digital recorder data. Figure 4-9 is a block diagram of one decade counter. Each binary responds only to true input pulses. When a binary is switched to the zero state, it sends a true pulse to the next binary causing it to switch.

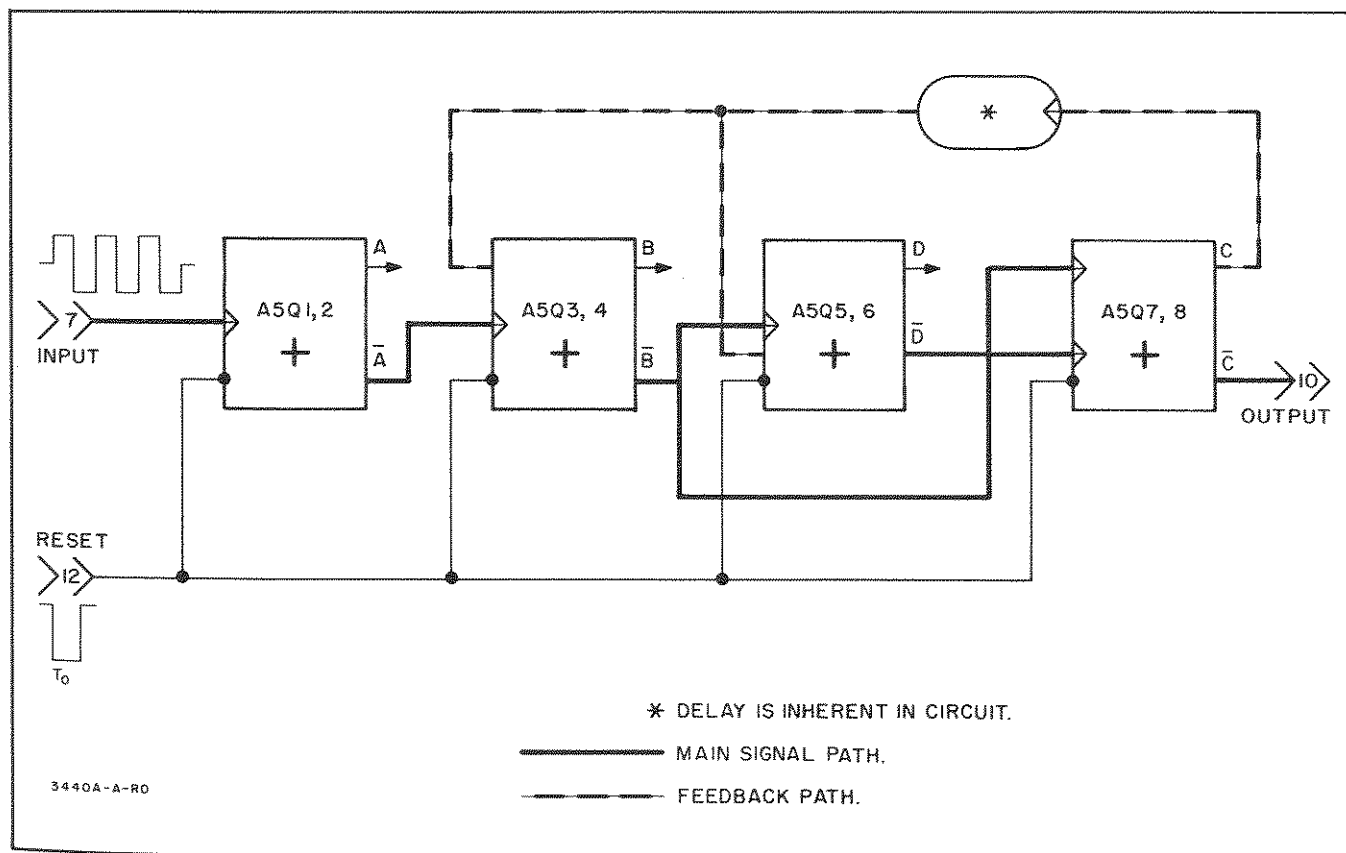


Figure 4-9. Decade Counter

Table 4-3. Counting Sequence of Decade Counter

DECIMAL COUNT	COUNTER STATE (□ ZERO STATE ■ ONE STATE)				4-LINE CODE AND WEIGHTING			
	A	B	D	C	A=1	B=2	D=4	C=2
0	□	□	□	□	0	0	0	0
1	■	□	□	□	1	0	0	0
2	□	■	□	□	0	1	0	0
3	■	■	□	□	1	1	0	0
4	□	□	■	□	0	1	0	1
5	■	■	□	■	1	1	0	1
6	□	□	■	■	0	0	1	1
7	■	□	■	■	1	0	1	1
8	□	■	■	■	0	1	1	1
9	■	■	■	■	1	1	1	1
0	□	□	□	□	0	0	0	0

3440A-A-R0

4-62. Each true pulse produces a different combination of binaries in the one state. There are only ten allowable combinations, and each one represents a particular decimal digit. Each binary is assigned a decimal weighting. In the zero state, the weight is zero; in the one state, the weights are: D=4, C=2, B=2, A=1. These decimal weights, when added, give the equivalent decimal digit. For example, if D, C, and A are in the one state, and B is in the zero state, the digit represented is $4+2+0+1=7$. In binary coded decimal (BCD) notation, the order of binaries is normally given so that the least significant digit is on the right (DCBA). For clarity in showing flow, the counters are shown schematically in ABDC order.

4-63. Table 4-3 shows the counting sequence for a typical decade counter. At time T_0 , the Reset pulse sets all binaries to the zero state (DCBA = 0000).

- a. The first input pulse switches A to the one state (DCBA = 0001).
- b. The second pulse switches A to the zero state; output $\bar{A}$ switches B to the one state (DCBA = 0010).
- c. The third pulse switches A to the one state (DCBA = 0011).
- d. The fourth pulse switches A to the zero state; output $\bar{A}$ switches B to the zero state; output $\bar{B}$ switches both D and C to the one state. After an inherent delay, output C returns B to the one state, and D to the zero state. Output $\bar{D}$ cannot change the state of C, since C has not recovered from its recent switching (DCBA = 0110).
- e. The fifth pulse switches A to the one state (DCBA = 0111).
- f. The sixth pulse switches A to the zero state; output $\bar{A}$ switches B to the zero state; output $\bar{B}$ switches D to the one state (DCBA = 1100).
- g. The seventh pulse switches A to the one state (DCBA = 1101).
- h. The eighth pulse switches A to the zero state; output $\bar{A}$ switches B to the one state (DCBA = 1110).
- j. The ninth pulse switches A to the one state (DCBA = 1111).
- k. The tenth pulse switches A to the zero state; output $\bar{A}$ switches B to the zero state; output $\bar{B}$ switches D to the zero state; output $\bar{D}$ switches C to the zero state (DCBA = 0000). Output $\bar{C}$ is a true pulse which serves as a carry pulse to the next Decade Counter. The counter is now in the state it was originally. Additional input pulses repeat the cycle just described.

4-64. DIGITAL DISPLAY AND STORAGE.

4-65. The BCD outputs of the decade counters are used to light neon lamps. These lamps in turn excite a photoconductor matrix, which decodes the BCD into a decimal readout. By the BCD pattern of the lamps, one and only one low resistance path is enabled through the Photoconductor matrix (lighted photo-

conductor elements have a resistance of about 20 kilohms; dark elements have a resistance of many megohms) to the digit display tube on the front panel. There are ten possible paths through the matrix, each of which is connected to a specific digit in the digit display tube.

4-66. The sequence required to light a neon lamp in the photoconductor exciter is discussed in this paragraph. It should be remembered that 1) a much higher voltage is required to fire a neon lamp than to maintain illumination in the lamp (for the lamps used in the Model 3440A, 70 volts for firing, and 55 volts for maintaining illumination) and 2) after application of the firing voltage, the lamp cannot fire immediately because of the time required for ionization. Arrangement of the photoconductor exciter circuit used in the Model 3440A is indicated in Figure 4-10B. Diodes connected between the lamps make it possible for the circuit to store a previous count even though the binaries are switching during the next counting period. To clarify certain aspects of the photoconductor exciter sequence, the circuits will first be discussed as though there were no diodes between the two lamps in each binary as shown in Figure 4-10A.

a. Lamp Circuit without Diodes

1. As indicated in Figure 4-10A-1, the lamp associated with the output A is lighted. Voltages shown are typical. The voltage across lamp $\bar{A}$ is established by conducting lamp A on one side and the false state of the output $\bar{A}$. This voltage is not high enough to fire lamp A.
2. When the binary changes state, current flow through lamp A decreases, and the voltage at the junction of the two lamps rises in magnitude to the firing voltage of lamp $\bar{A}$. After lamp $\bar{A}$ lights, the voltage across it stabilizes at about 55 volts, extinguishing lamp A as shown in Figure 4-10A-2.

b. Lamp Circuit with Diodes

1. The steady or storage state of the lamp circuit is indicated in Figure 4-10B-1. The diodes are forward-biased, effectively connecting the lamps in parallel. Conducting lamp $\bar{A}$ holds the voltage across both lamps at about 55 volts, which is insufficient to fire lamp A.
2. At time T_2 , the Transfer pulse goes false, reverse biasing the diodes, which disconnects the lamps from each other and connects them to the binary. If the binary is in the same state as the lamps, then the proper voltage is present to maintain the lamps in their previous state. If the binary has switched, the lamps change state as described in sub-paragraph 4-66a. Condition of the circuit while lamp A is ionizing is shown in Figure 4-10B-2; condition after the lamp has fired is shown in Figure 4-10B-3.
3. At time T_0 , the Transfer pulse goes true, forward biasing the diodes and storing the count.

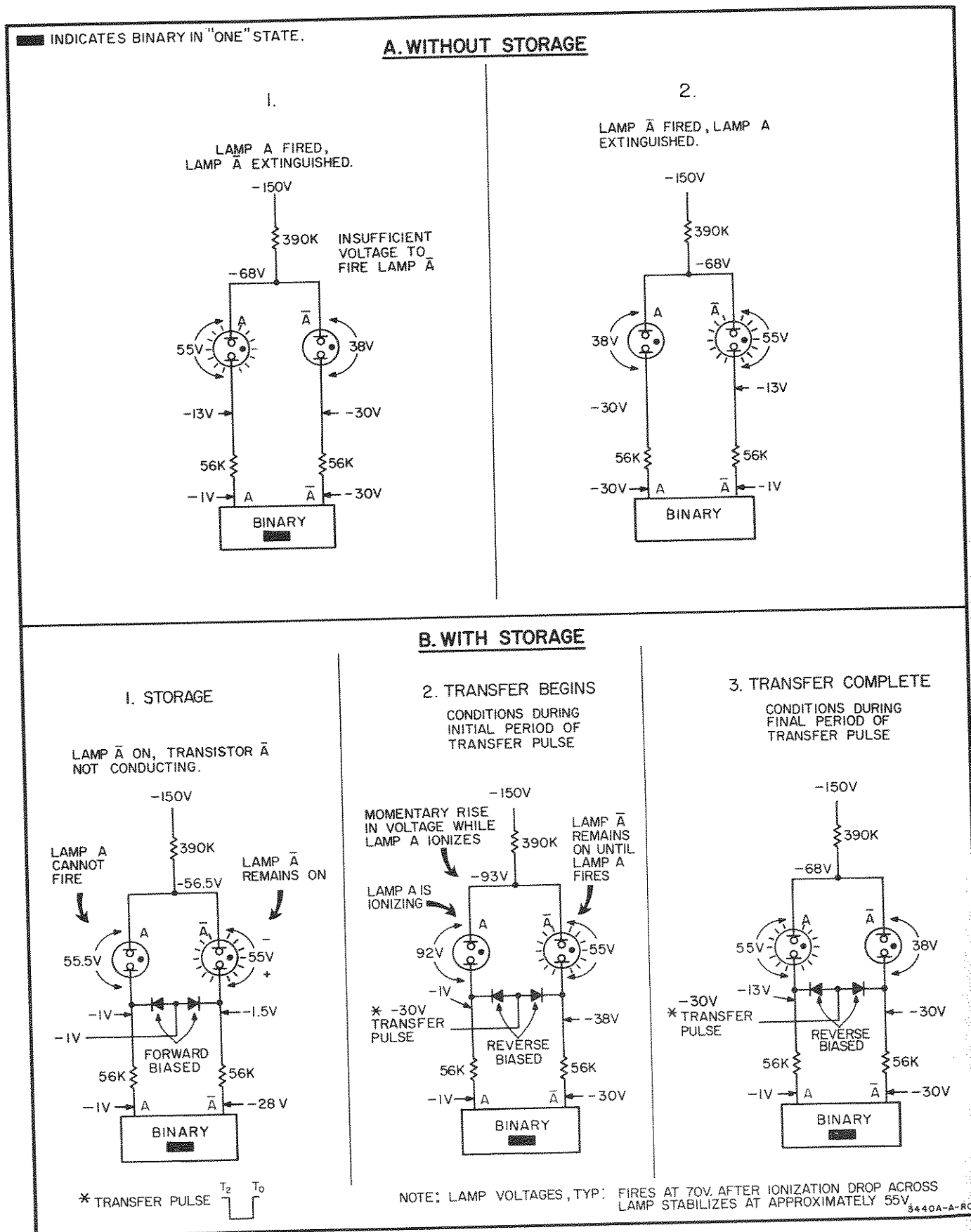


Figure 4-10. Lamp Control

4-67. OVERRANGE SENSOR.

4-68. At time T_0 , the Reset pulse insures that the Overrange Sensor (A4Q8, 9) is in the zero state. If the input voltage to the input comparator is greater than 9.999 volts, an overflow pulse will be generated by Thousands Decade Counter A8. This pulse sets the Overrange Sensor to the one state lighting the front panel OVERRANGE lights DS6 and DS7. Overrange Sensor R sends a pulse to the Plug-in unit to actuate the auto-ranging circuits and the function print-out. (Refer to Plug-in manual for discussion of auto-ranging circuits.)

4-69. DIGITAL RECORDER.

4-70. BCD information is supplied to the rear panel DIGITAL RECORDER jack from each binary. Range and function information is also supplied to this jack in BCD form by the Plug-in (refer to Plug-in manual for description). At time T_2 , the Model 3440A generates a Print Command to actuate the Digital Recorder, printing the data obtained during the last sample (refer to paragraphs 4-30 through 4-32 for discussion of the Print Command).

4-71. POWER SUPPLY.**4-72. PRIMARY POWER.**

4-73. Either 115 or 230 volt ac power is connected through fuse F1 (0.6 amp slo-blo) and switch S2 (or SAMPLE RATE control) to the primary of power transformer T1. Switch S6 connects T1 primaries in parallel for 115 volt operation or in series for 230 volt operation.

4-74. UNREGULATED POWER SUPPLIES.

4-75. Full wave rectifier A9CR6 - 9 produces -150 volts and +150 volts for driving neon lamps and digit display tubes.

4-76. REGULATED POWER SUPPLIES.

4-77. Full wave rectifier A9CR1 - 4 produces +12 volts which is shunt regulated by breakdown diode A9CR12.

4-78. Full wave rectifier A9CR1 - 4 also provides -35 volts which is series regulated by transistor Q1. Breakdown diode A9CR11 provides a reference voltage to the control amplifier A9Q1, 2. The -35 volt supply is adjusted by A9R12. F2, the -35 volt fuse provides protection for the supply.

Table 5-1. Recommended Test Equipment

Instrument Type	Required Characteristics	Use	Recommended Model
DC Standard	Voltage Range: 0 - 1000 volts Accuracy: $\pm 0.01\%$ of reading	Performance Checks Adjustment	Φ Model 740A
Digital Recorder	6 column print: 1-2-2-4 BCD Print Rate: 5 lines/second	Performance Checks	Φ Model 562A
Pulse Generator	Pulse Width: 20 μ sec Amplitude: +10 volts Repetition Rate: Manual	Performance Checks	Φ Model 214A
Wide Range Oscillator	Frequency: 60 cps Amplitude: 1 volt p-p	Performance Checks	Φ Model 200CD
AC Voltmeter	Voltage Range: 0 - 1 volt Accuracy: $\pm 2\%$	Performance Checks	Φ Model 403B
DC Voltmeter	Voltage Range: 0 - 100 volts Accuracy: $\pm 1\%$ Input Impedance: > 10 M ohms	Adjustment	Φ Model 412A
Electronic Counter	Range: to 400 kc	Adjustment	Φ Model 5532A
Transistor Power Supply	0 - 30 vdc; 0 - 15 ma	Troubleshooting	Φ Model 721A
Oscilloscope	Bandwidth: DC - 5 Mc Dual Channel Capability: Delayed Sweep Capability	Troubleshooting	Φ Model 175A with Φ Model 1781B Horizontal Plug-in Φ Model 1750A Vertical Plug-in Φ 10003A 10:1 Probe
Variable Transformer	Output Voltage: 103 to 127 vac (or 207 to 253 vac)	Performance Checks Adjustment	Superior Electric Co. Powerstat 3PF116 (for 115 V line) 3PF216 (for 230 V line)
Toggle Switch	Single pole - single throw	Performance Checks	Φ #3101-0001
Resistor	1.0 Megohm, 1/2 watt, $\pm 1\%$	Performance Checks	Φ #0727-0276
Resistor	82 K ohms, 1/4 watt, $\pm 5\%$	Performance Checks	Φ #0683-8235
Nylon Tuning Wand		Adjustment	Φ #8730-0016
15 pin extender board		Troubleshooting Adjustment	Φ #5060-0049
22 pin extender board		Troubleshooting Adjustment	Φ #5060-0630
Soldering Iron and Tips	Wattage Rating: 50 watts Minimum tip temperature: 700° F Tip Size: 1/16" to 3/32"	Troubleshooting Repair	Ungar #776 Handle Ungar #PL333 Tipset

SECTION V

MAINTENANCE

5-1. REQUIRED TEST EQUIPMENT.

5-2. Recommended test equipment for maintaining and checking performance of the Model 3440A is listed in Table 5-1. Test instruments other than those listed may be used if their specifications equal or exceed the required characteristics.

5-3. PERFORMANCE CHECKS.

5-4. Use the following front and rear panel procedures to verify proper operation of the Model 3440A. The Model 3440A and test equipment should be operated at 115/230 vac unless otherwise specified. If the Model 3440A is found to be out of specifications at any point in this procedure, refer to paragraph 5-13, ADJUSTMENTS.

5-5. CALIBRATION.

- Connect Model 3440A as shown in Figure 5-1.
- Set line voltage to 115/230 vac; switch Model 3440A power on with SAMPLE RATE control.
- Allow Model 3440A to warm-up for 1/2 hour.
- Insuring that DC Standard OUTPUT is OFF, short Model 3440A INPUT terminals (⚡ to red).
- Set RANGE switch on Plug-in to 10 V (0.000).
- Adjust rear panel ZERO for a front panel display of 0.000. Optimum adjustment is indicated by alternate flashing of the (+) and (-) lights.

g. Remove short from INPUT terminals.

h. Depress INT CHECK 8000 button and adjust INT CHECK 8000 for a front panel display of -8.000.

j. Check Model 3440A readout against DC Standard voltages listed in Table 5-2. This table may be used on 10, 100, and 1000 volt ranges by proper placement of the decimal point.

CAUTION

When using the  Model 740A DC Standard, do not exceed -500 volts.

k. Repeat step j for line voltages of 103 and 127 vac (207 and 253 vac).

Table 5-2. Calibration

DC Standard	Model 3440A	
	Minimum	Maximum
0000	-0001	+0001
1000	0998	1002
2000	1998	2002
3000	2997	3003
4000	3997	4003
5000	4996	5004
6000	5996	6004
7000	6995	7005
8000	7995	8005
9000	8994	9006
10000	9994	0006*

*indicates OVERRANGE lamp should be lighted.

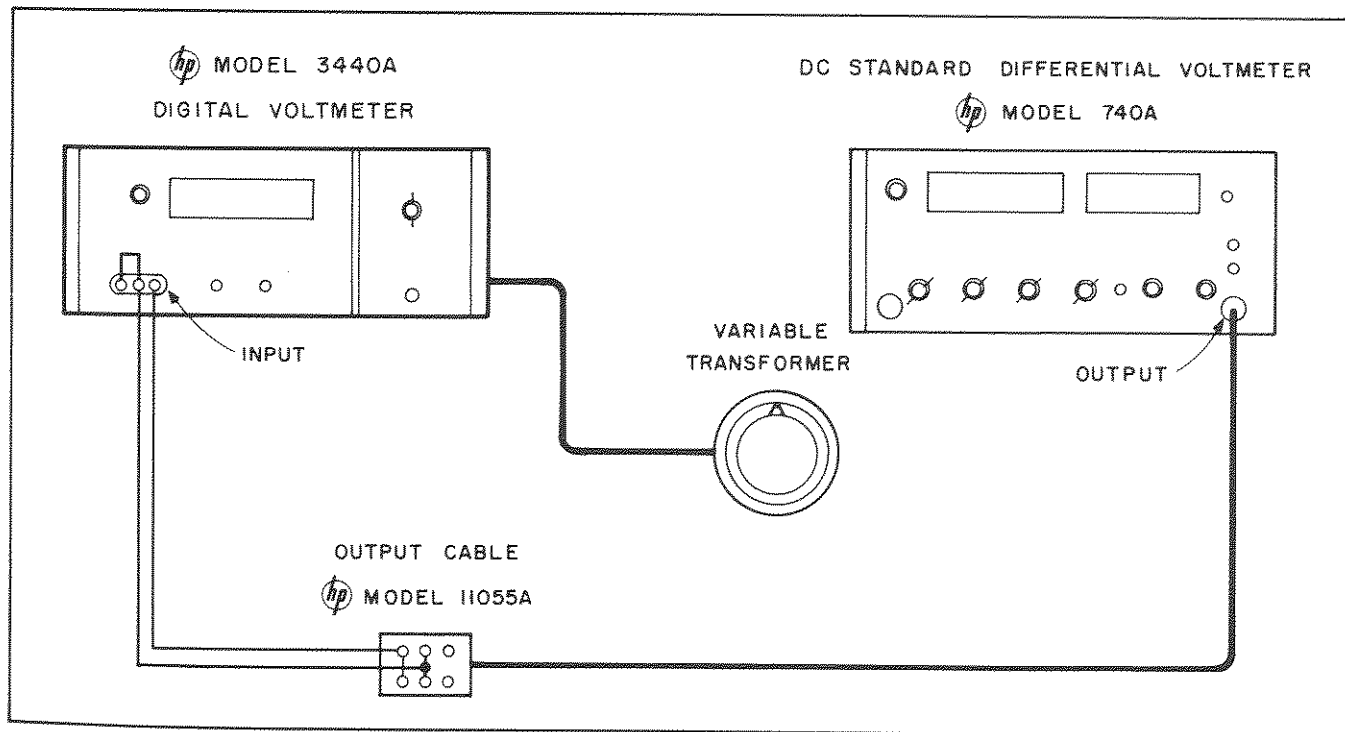


Figure 5-1. Calibration

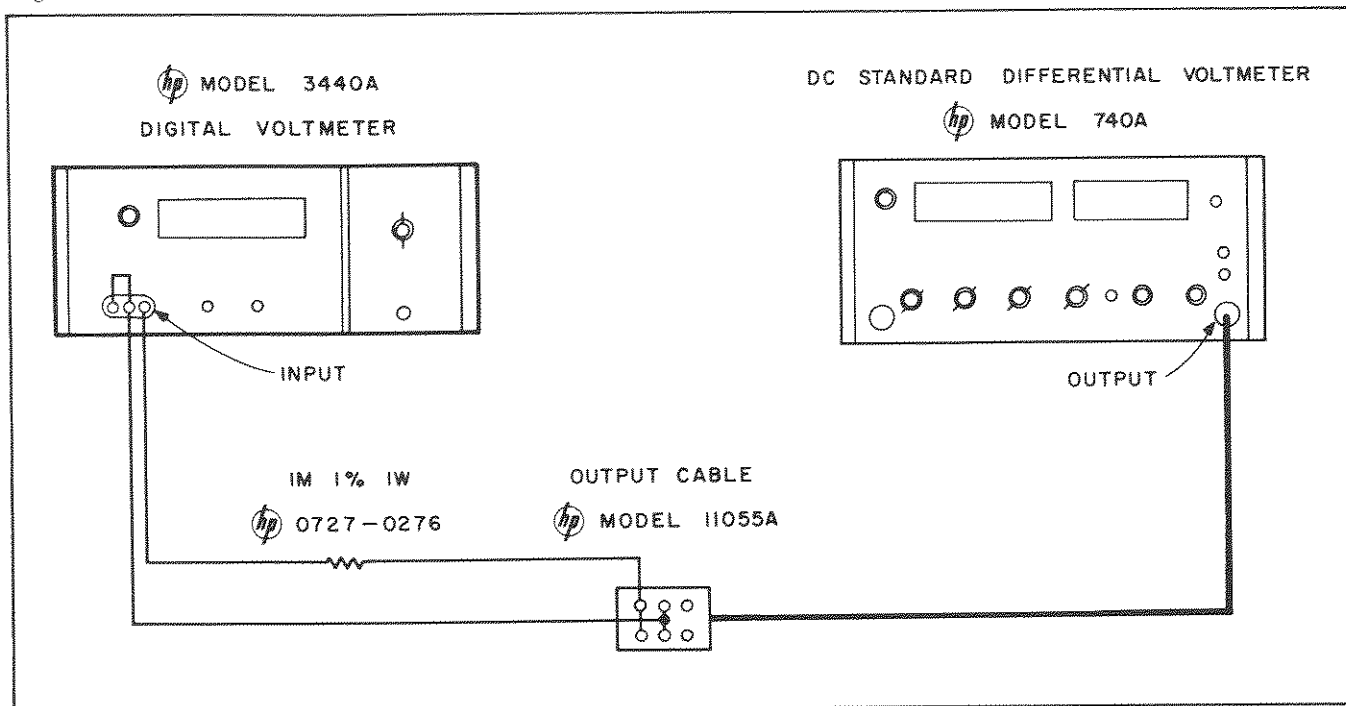


Figure 5-2. Input Impedance Check

5-6. INPUT IMPEDANCE CHECK.

- Connect Model 3440A as shown in Figure 5-2.
- Set RANGE switch on Plug-in to 10 V.
- Set DC Standard to 10.00 volts.
- The Model 3440A readout should indicate between 9.090 and 9.122.

NOTE

This corresponds to an input resistance of 10.0 to 10.4 megohms where:

$$R_{\text{input}} = \frac{E_{3440A}}{10.00 - E_{3440A}} \times 1.0 \times 10^6 \text{ ohms}$$

5-7. EXTERNAL TRIGGER CHECK.

- Set SAMPLE RATE to HOLD.

- Connect an SPST toggle switch between pins 17 and 18 of REMOTE CONTROL connector (J4) on rear panel.
- Observe that SAMPLE RATE indicator flashes each time the switch is closed.
- Connect Model 3440A as shown in Figure 5-3.
- Set Pulse Generator controls as follows:
 TRIGGER MODE MAN.
 PULSE WIDTH 20 μ sec
 PULSE AMPLITUDE 10
 PULSE OUTPUT (+)
- Observe that SAMPLE RATE indicator flashes each time Pulse Generator MANUAL button is depressed.

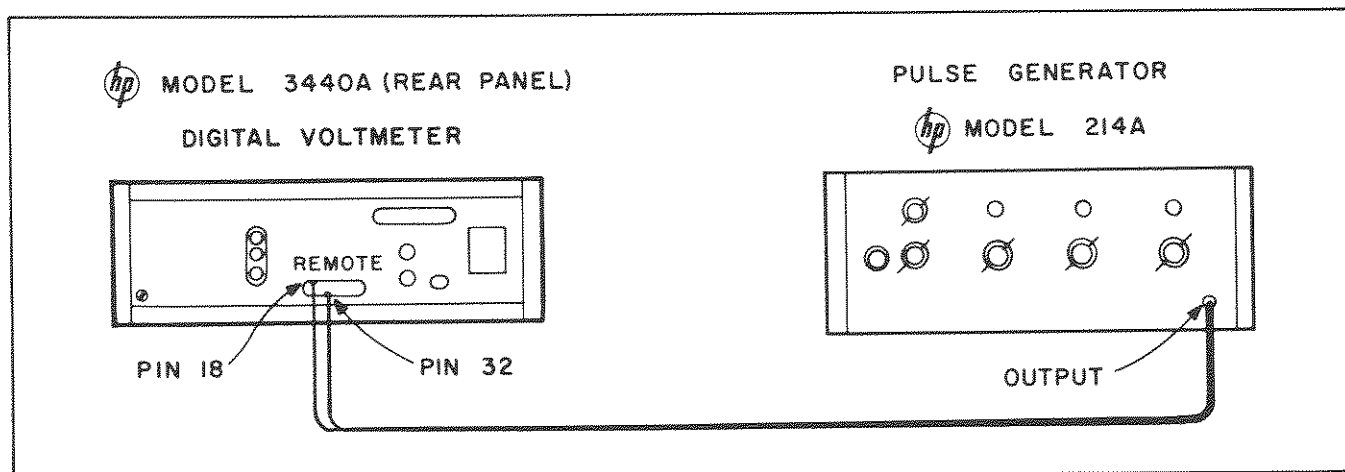


Figure 5-3. External Trigger Check

5-8. DIGITAL RECORDER CHECK.

- a. Connect Model 3440A as shown in Figure 5-4.

NOTE

Insure that both Model 3440A and DC Standard are isolated from power line ground.

- b. Set SAMPLE RATE for 5 samples per second.
c. Set DC Standard for Model 3440A readouts as shown in Table 5-3. Digital Recorder second thru fifth column printouts should correspond.

5-9. INPUT FILTER RESPONSE TIME CHECK.

- a. Connect Model 3440A as shown in Figure 5-4.

NOTE

Insure that both Model 3440A and DC Standard are isolated from power line ground.

Table 5-3. Digital Recorder Check

3440A Display	Digital Recorder Printout
+1.111	011113
+2.222	022223
+3.333	033333
+4.444	044443
+5.555	055553
+6.666	066663
+7.777	077773
+8.888	088883
+9.999	099993
-1.000	110003
+10.00	010002
+100.0	010001
+00.50*	900502

*indicates 100.50 volt input; OVERRANGE lighted.

NOTE

Refer to the Plug-in manual for proper function and range printout.

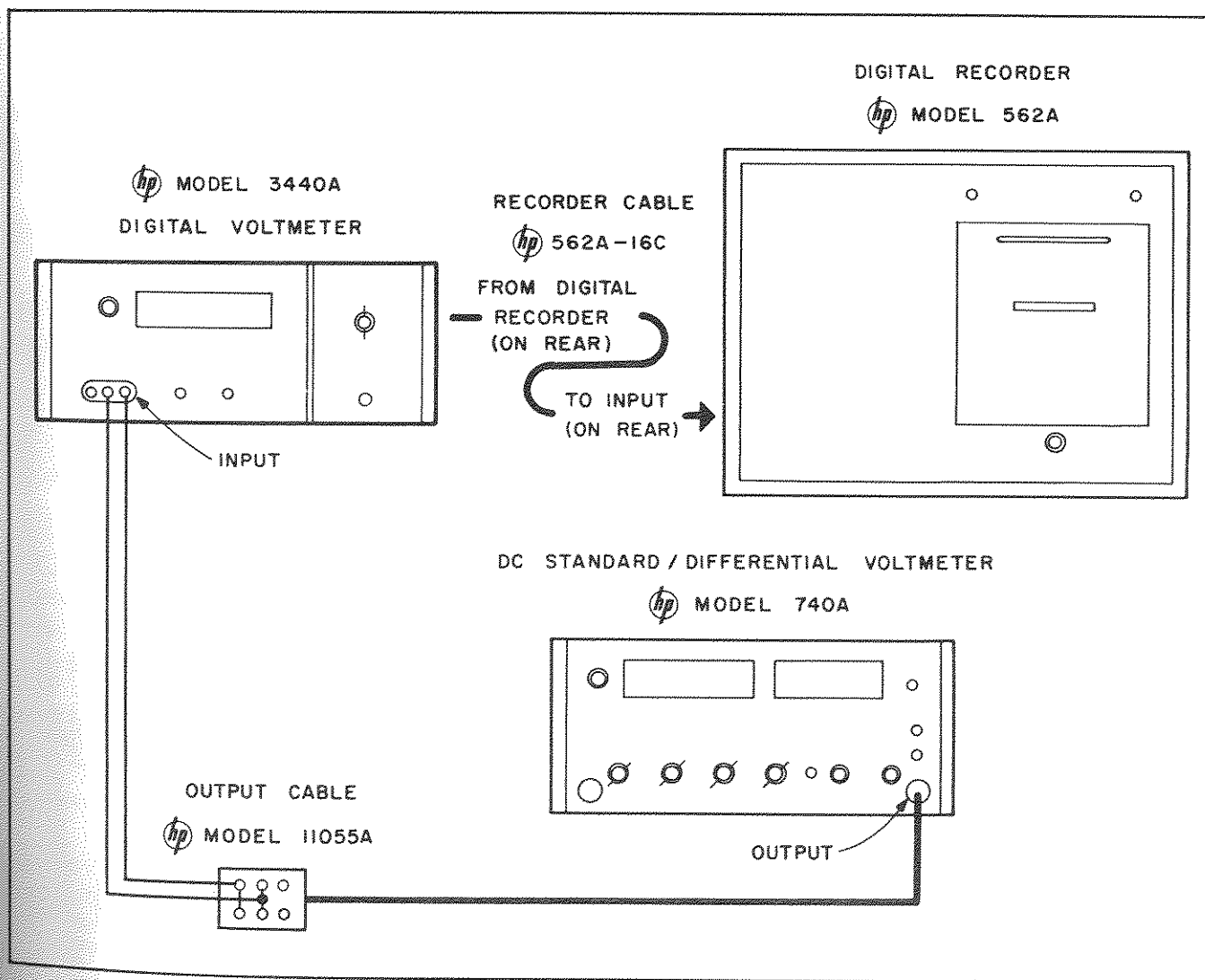


Figure 5-4. Digital Recorder Check

b. Set instrument controls as follows:

Model 3440A

SAMPLE RATE . . . 5 samples/second
RANGE 1000 V

DC Standard

VOLTAGE SET. . . 5000 (500.0 volts)
RANGE 1000 V
FUNCTION STD
OUTPUT OFF

Digital Recorder

RECORD ON

c. Digital Recorder should be printing zeros.
(0000001 or 1000001)

d. Switch DC Standard OUTPUT to ON.

e. The Model 3440A readout should be within
0.05% of final value within 450 msec. This will
be seen on the third printout.

5-10. INPUT FILTER AC REJECTION CHECK.

a. Connect Model 3440A as shown in Figure 5-5.

NOTE

Insure that all instruments except
the Digital Recorder are isolated
from power line ground.

b. Set instrument controls as follows:

Model 3440A

SAMPLE RATE . . . 5 samples/second
RANGE (on Plug-in) . . . 10 V

DC Standard

FUNCTION STD
RANGE 10 V
OUTPUT ON

Wide Range Oscillator

FREQUENCY 6
RANGE X10
AMPLITUDE max CCW

Digital Recorder

RECORD ON

AC Voltmeter

RANGE 1 V

c. Adjust DC Standard for Model 3440A reading
of +8.000 volts.

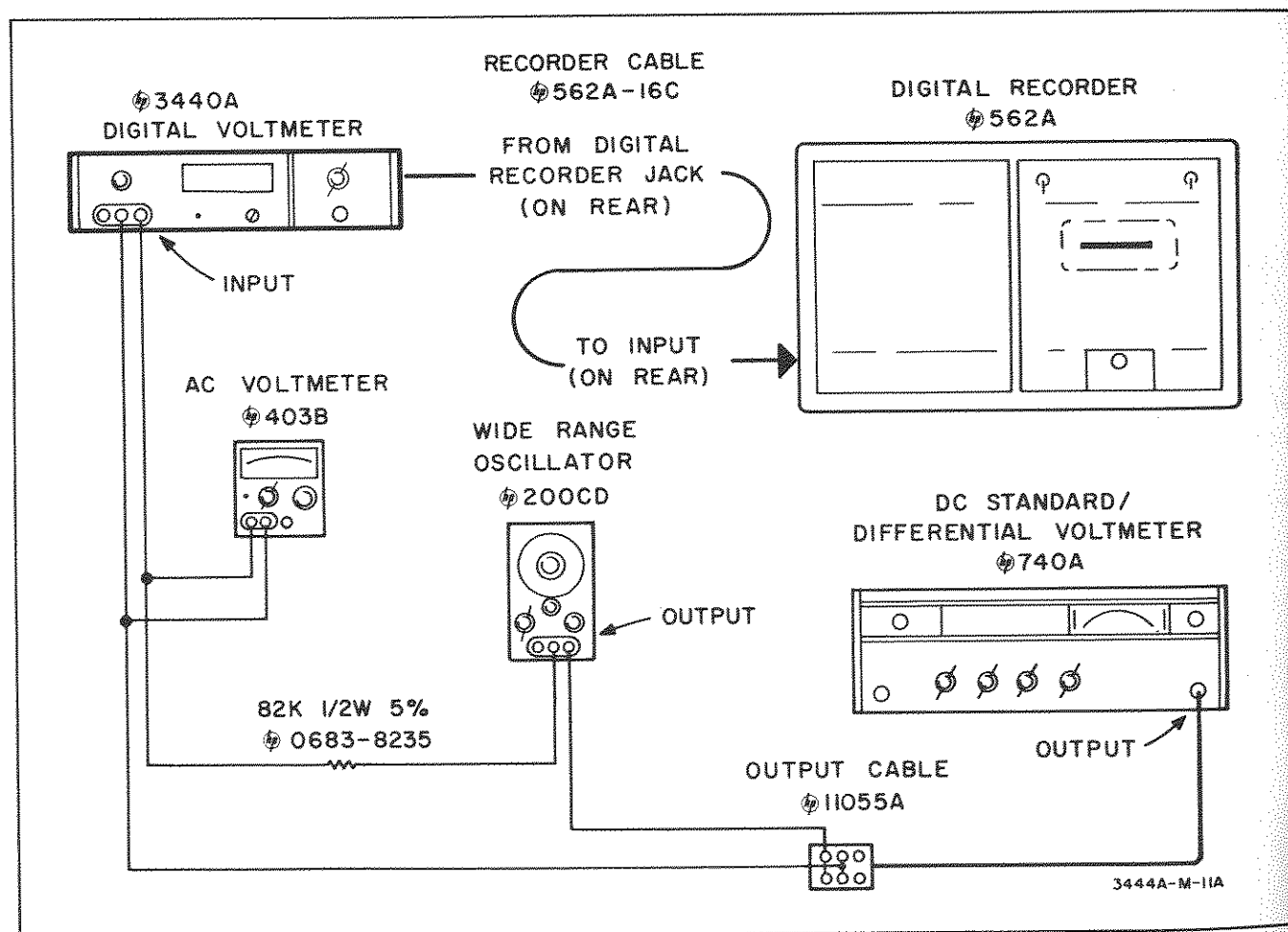


Figure 5-5. Input Filter AC Rejection Check

- d. Increase Wide Range Oscillator AMPLITUDE for a reading of 0.35 volts rms on AC Voltmeter.
- e. Digital Recorder printout should be between 079833 and 080173 (corresponding to a value between 7.983 and 8.017 volts).

NOTE

This corresponds to an ac rejection of 30 db where:

$$\text{rejection in db} = 20 \log \frac{E \text{ in (rms)}}{\Delta E_{3440A} \text{ (p-p)}} \times 2.82$$

5-11. INSTRUMENT COVER REMOVAL.

5-12. To remove either the top or bottom covers, remove the two Phillips-head screws which secure the cover to the instrument. Slide the cover approximately 1/2 inch to the rear of the instrument and lift free. To replace the cover, reverse the procedure.

5-13. ADJUSTMENT AND CALIBRATION PROCEDURES.

5-14. The following test and adjustment procedures should be performed only if it has been definitely determined by the Performance Checks given in paragraphs 5-3 through 5-10 that the Model 3440A is out of specifications.

5-15. POWER SUPPLY A9 ADJUSTMENT.

- a. Supply Model 3440A primary power through a variable transformer.
- b. Set line voltage to 115/230 vac.
- c. Set SAMPLE RATE control to HOLD.
- d. Connect DC Voltmeter to A9 (4). (See Figure 5-20.
- e. Reading should read between +145 and +160 vdc.
- f. Connect DC Voltmeter to A9 (1).
- g. Reading should read between -145 and -160 vdc.
- h. Connect DC Voltmeter and AC Voltmeter to A9 (10).
- j. DC Voltmeter should read between +11.0 and +14.0 vdc.
- k. Vary line voltage from 103 to 127 (207 to 253) vac.
- m. DC Voltmeter reading should not change more than ± 0.3 vdc. AC Voltmeter reading should remain below 2 mv.
- n. Connect DC Voltmeter and AC Voltmeter to A9 (15).
- p. Adjust A9R12 (-35 v adj) for DC Voltmeter reading of -35.0 vdc.
- q. Vary line voltage from 103 to 127 (207 to 253) vac.
- r. DC Voltmeter reading should not change more than ± 0.2 vdc. AC Voltmeter reading should remain below 4 mv.

5-16. OSCILLATOR A9 FREQUENCY ADJUST.

- a. Set SAMPLE RATE control to HOLD.

b. Connect a clip lead from A4Q2 base (see Figure 5-15) to circuit common. This causes synchronized oscillator to free run.

c. Connect Electronic Counter to A9TP1. (See Figure 5-16.)

d. Adjust A9C14 for an Electronic Counter reading of 400.0 kc, ± 40 cps.

5-17. GROUND COMPARATOR BALANCE AND CHARGE RESTORER ADJUST.

- a. Set SAMPLE RATE control to maximum counterclockwise (but not LINE OFF).
- b. Set RANGE switch on Plug-in to 10 V.
- c. Short Model 3440A INPUT terminals.
- d. Adjust R2 (ZERO) until readout is 0.000. Optimum adjustment is indicated by alternate flashing of the (+) and (-) lights.
- e. If R2 has insufficient range to obtain a zero reading, proceed as follows:
 - 1. Set R2 to mechanical midpoint.
 - 2. Adjust A2R70 (Comparator Balance) until readout display is 0.000 (see Figure 5-13).
 - 3. Repeat step d for fine adjustment.
- f. Remove short from INPUT terminals.
- g. Adjust A2R40 (charge restorer) until readout display is 0.000. Optimum adjustment is indicated by alternate flashing of the (+) and (-) lights.
- h. Set SAMPLE RATE to approximately one sample per second.
- j. Reading should remain at zero. If not, repeat steps c thru g.

5-18. CALIBRATION.

- a. Set RANGE switch on Plug-in to 10 V.
- b. Apply +8.000 volts from DC Standard to INPUT terminals.
- c. Set front panel INT CHECK 8000 adjust to approximately the mechanical midpoint (this is a ten turn potentiometer).
- d. Adjust A3R51 (Ramp Slope) for front panel display of +8.000. (See Figure 5-13.) Front panel INT CHECK 8000 adjust may be used for fine adjustment.
- e. Set RANGE switch on Plug-in to 100 V.
- f. Apply +80.00 volts from DC Standard to INPUT terminals.
- g. Adjust A1R7 (100 V Adj) for front panel display of +80.00. (See Figure 5-10.)
- h. Set RANGE switch on Plug-in to 1000 V.
- j. Apply +800.0 volts from DC Standard to INPUT terminals.
- k. Adjust A1R8 for front panel display of +800.0.
- m. Apply -8.00 volts from DC Standard.
- n. Set RANGE switch on Plug-in to 10 V.

Table 5-4. Troubleshooting Aid

Symptom	Possible Cause
1. Display not lit	Fuse F1 (0.6 a slow-blow); 115/230 volt switch S6, LINE switch S2, Power Transformer T1 Power Supply A9
2. Display lit, no response to input SAMPLE RATE not lit	Power Supply A9, -35 volt fuse F2 (0.75a), Sample Rate Multivibrator (A3Q5, 6), Ramp Gate (A3Q10, 11), Ramp Generator (A3QCR1, A3Q15 - 17), Ramp Sensor (A3Q7, 8)
3. Display lit, no response to input Power Supply voltages normal, SAMPLE RATE lit continuously	Sample Rate Multivibrator (A3Q5, 6), Ramp Gate (A3Q10, 11), Ramp Generator (A3QCR1, A3Q15 - 17) Ramp Sensor (A3Q7, 8)
4. SAMPLE RATE normal, display counting continuously, Polarity normal	Reset Amplifier (A3Q2, 3) AND Gate (A2CR22, 23), AND Gate Amplifier (A4Q1), Count Gate (A4Q2 - 4), Synchronized Oscillator Gate (A9Q4)
5. SAMPLE RATE normal, display will not change	Reset Amplifier (A3Q2, 3), Transfer Amplifier (A3Q12), AND Gate (A2CR22, 23), AND Gate Amplifier (A4Q1), Count Gate (A4Q2 - 4), Synchronized Oscillator (A9Q4 - 8), Decade Counter (A5 - A8)
6. SAMPLE RATE normal, display continuously counting, polarity always indicates (+)	Input Comparator (A2Q1 - 5, A2Q6 - 9)
7. SAMPLE RATE normal, display continuously counting, polarity always indicates (-)	Ground Comparator (A2Q11 - 13, A2Q15, 16)
8. Particular digit(s) displayed erratically	Decade Counter Assemblies (A5 - A8)
9. Improper tracking	Ramp Generator A3QCR1, A3Q15 - 17
10. No response to input with normal indication on INT CHECK 8000	Attenuator (A1) Plug-in Unit

- p. Adjust INT CHECK 8000 for a reading of -8,000 if necessary.
- q. Depress INT CHECK 8000 button.
- r. Adjust A3R60 (Reference 8000) for front panel display of -8,000.

5-19. TROUBLESHOOTING.

5-20. Use the Troubleshooting Procedure only after determining that the difficulty cannot be removed by the Adjustment and Calibration Procedure, paragraph 5-13.

5-21. Inspect the set up used when symptoms of malfunction were observed to be certain that the source of the trouble is not external of the Model 3440A.

5-22. Look for burned or loose components, loose connections, broken wires, or any other similar condition which suggests a source of trouble.

5-23. The following should be used to isolate the trouble to a particular circuit board:

- a. Front panel symptoms;
- b. Difficulties encountered during Adjustment and Calibration Procedure (paragraphs 5-13 and 5-18);
- c. Simplified Block Diagram (Figure 4-1);
- d. Detailed Block Diagram (Figure 4-2);
- e. Troubleshooting Aid (Table 5-4);
- f. Waveform Time Sequence (Figure 5-7);
- g. Typical Waveforms (Figure 5-8).

5-24. When malfunctioning assembly is found, the trouble may then be traced to the individual components by using the procedures outlined in paragraphs 5-25 through 5-38. The order of testing shown should be followed. If a particular circuit is known to be functioning properly, the tests for that circuit may be omitted.

5-25. POWER SUPPLY A9.

5-26. For power supply problems, check diodes (A9CR1 - 4, A9CR6 - 9, A9CR11, 12) and regulator transistors (Q1, A9Q1, A9Q2).

5-27. SAMPLE RATE AND RAMP GENERATOR TEST.

5-28. If SAMPLE RATE neon is either not lit or lit continuously, the problem is in the A3 circuit board. The source of trouble is usually difficult to determine because of the feedback loop used to reset the Sample Rate Multivibrator. To locate the malfunction, use the following procedure:

- a. Disconnect the emitter of A3Q8, (see Figure 5-11) from the circuit board. This breaks the feedback loop.

CAUTION

Use extreme care in removing the lead as it is very easily broken.

- b. Connect negative output of Transistor Power Supply to the emitter of A3Q8, using insulated miniature clip leads. Connect positive output to Model 3440A circuit common.
- c. Set Transistor Power Supply to -11 and -13 vdc and observe the voltage levels at the points given in Table 5-5.
- d. If the proper voltage is not present at any point, the malfunction is probably immediately before that point.

NOTE

A reading of approximately -16 vdc at the collector of A3Q11 indicates that A3QCR1, A3Q15, or A3Q16 is shorted from emitter to collector. These voltages are approximate, and any value within $\pm 20\%$ should be considered normal.

Table 5-5. Sample Rate and Ramp Generator Test

Transistor Power Supply Voltage	-11	-13
SAMPLE RATE Neon	ON	OFF
A3Q7 Base	+12.5	0
A3Q7 Collector	-1.4	0
A3Q5 Collector	-1.5	-14
A3Q6 Collector	-26	-1.5
A3Q10 Base	0	-6.6
A3Q10 Collector	0	13
A3Q11 Collector	-22	13
A3CR11 Cathode	-22.5	12
A3QCR1 Emitter	-18	12
A3QCR1 Anode	-24.5	5.5
A3Q17 Emitter	-24	-23
A3Q1 Base	-4.0	0.5

5-29. RESET PULSE.

5-30. The reset pulse (see Figure 5-8B) is necessary for proper operation of most Model 3440A circuits. If the SAMPLE RATE neon is flashing and the reset pulse is not present, the trouble is probably A3Q2 or A3Q3 (see Figure 5-13).

5-31. VOLTAGE COMPARATOR A2.**NOTE**

Reference Designators in parenthesis are located in the ground comparator.

- a. Check waveform (Figures 5-8G and 5-8L) at A2TP2 (A2TP4). (See Figure 5-12.)
- b. If proper waveform is not observed, check waveform (Figures 5-8F and 5-8K) at A2TP1 (A2TP3).
- c. If proper waveform is observed here, the trouble is probably A2Q7 or A2Q8 (A2Q15 or A2Q16). If not, go on to step d.
- d. Disconnect A2R34 from A2Q5 collector (A2R81 from A2TP3).
- e. Connect negative output of transistor power supply to A2R34 (A2R81). Connect positive output to Model 3440A circuit common.
- f. Vary transistor power supply voltage between -16 and -20 vdc.
- g. A corresponding change should be seen at the collectors of A2Q1 - 5 (A2Q11 - 13). If this change is not seen at any one point, the trouble is probably the transistor immediately before that point.
- h. If this does not isolate the trouble, the problem is probably caused by defective A2CR5 (A2CR27) or A2CR10.

5-32. ZERO OFFSET.

5-33. If the Model 3440A cannot be zeroed by adjusting A2R70 (see Figure 5-12), use the following procedure:

- a. Clean the plug-in connector J6 and P6 with Type TF Freon (ϕ Stock Number 8500-0232).
- b. If this does not help, short the INPUT terminals.
- c. If the instrument can now be zeroed by adjusting A2R70, the trouble is probably in the Charge Restorer (A2Q9), A2CR10, 11 or A2CR15 - 17.
- d. If the instrument still cannot be zeroed, the problem is probably A2CR27 - 28, A2CR5 - 7, or A2R68 - 71.

5-34. INPUT FILTER AC REJECTION.

5-35. Poor ac rejection can be caused by defective A1C1, A2C1, or Plug-in unit.

5-36. INPUT IMPEDANCE.

5-37. Excessive leakage current can be caused by a defective A2CR10, A2C1, A2C4, A2CR5B, Input Attenuator or Plug-in unit.

5-38. COUNT GATE AND POLARITY SENSOR.

- a. If neither Polarity Sensor (A4Q6 - 7) or Count Gate (A4Q1 - 4) is functioning properly disconnect A4R29 and A4R41. (See Figure 5-15.)
- b. If Count Gate now functions properly, the trouble is probably the Polarity Sensor (A4Q6, 7).
- c. If Count Gate still does not function properly, the trouble is probably A4Q1 - 4.

5-39. SYNCHRONIZED OSCILLATOR.

- a. Connect clip lead from A4Q2 base to circuit common.
- b. Check waveform (Figure 5-8T) at A9TP1 (see Figure 5-19).
- c. If proper waveform is not observed, ground the collector of A9Q4.
- d. If this causes the proper waveform to appear at A9TP1, the trouble is probably A9Q4.
- e. If there still is no output at A9TP1, check the waveform at the collector of A9Q5. (See Figure 5-8S.)
- f. Proper waveform at this point indicates the trouble is in the Schmitt Trigger (A9Q6 - 8). Improper waveform indicates the problem is the Oscillator A9Q5.

NOTE

If the oscillator is unstable check that the value of A9R24 is 10 kilohms.

5-40. DECADE COUNTERS A5 - A8.

- a. Place suspected Decade Counter in A5 position. This sets up worst case conditions.
- b. Connect clip lead from A4Q2 base to circuit common causing oscillator to free run.
- c. Observe waveform (see Figure 5-8X) at A5 (10).
- d. If proper waveform is observed, the trouble is probably Photoconductor Assembly V1, Digit Display Tube DS6, or Transfer Amplifier A3Q12.
- e. If improper waveform is observed at this point, observe waveforms of each binary. (See Figures 5-8U thru 5-8W.)
- f. Improper waveform indicates defective binary.

5-41. OVERRANGE.

5-42. OVERRANGE indicator problems can be caused by defective A4Q8, A4Q9, A4CR10, or A4DS3.

5-43. CALIBRATION LINEARITY.

5-44. If Model 3440A fails to track properly, check the following:

- a. Oscillator A9 stability.
- b. Ramp Generator A3QCR1, A3Q15 - 17.

5-45. DIGITAL RECORDER.

5-46. If Digital Recorder fails to print properly, check the following:

- a. Digital Recorder;
- b. Interconnecting cable between Model 3440A and Digital Recorder;
- c. Decade Counter binary outputs;
- d. Print Command A3Q18 (see Figure 5-8);
- e. Plug-in Unit.

5-47. SERVICE AND REPAIR.

5-48. DECIMAL ASSEMBLY A10 AND FUNCTION ASSEMBLY A11 REMOVAL.

- a. Remove Assemblies A2 and A3.
- b. Remove A2 and A3 support bracket.
- c. Remove screw holding Function Assembly A11. Assembly A11 can now be slid back for repair.
- d. Remove Assemblies A4 through A8.
- e. Remove two front-panel screws holding read-out assembly.
- f. Remove two screws in molded Decimal Assembly holder. The Decimal board is now accessible for repair.
- g. To reassemble, reverse steps f thru a.

CAUTION

Do not reverse polaroid window.

5-49. ETCHED CIRCUIT BOARD REPAIR.

5-50. The Model 3440A uses plated through double sided etched circuit boards. To prevent damage to the circuit board and components, observe the following rules when soldering:

- a. Use a low-heat (25 to 50 watts) soldering iron with a small tip (1/16" to 3/32" dia.).
- b. To remove a component, clip a heat sink (long nose pliers, commercial heat sink tweezers, etc.) on the component lead as close to the component as possible. Place the soldering iron directly on the component lead and pull up on the lead. If a component is obviously damaged or faulty, clip the leads close to the component and then remove the leads from the board.

CAUTION

Excessive or prolonged heat can lift the board or cause damage to components.

c. Clean the component lead holes by heating the solder in the hole, quickly removing the soldering iron, and inserting a pointed, non-metallic object such as a toothpick.

d. To mount a new component, shape the leads and insert them in the holes. Clip a heat sink on the component, heat with the soldering iron, and add solder as necessary to obtain a good electrical connection.

e. Clip excess leads off after soldering and clean excess flux from the connection and adjoining area, using type TF Freon (Ⓢ Stock Number 8500-0232).

5-51. POWER SUPPLY MODIFICATIONS.

5-52. POWER SUPPLY (Model 3440A Below Serial Number 415-00726).

5-53. When using the Model 3440A with Ⓢ Model 3443A High Gain/Auto Range Unit, the values of

A9R15 and A9R16 should be 1.2 K ohms, fixed composition $\pm 10\%$, 1/2 watt (stock number 0687-1221) to prevent overloading of the power supply. Instruments with serial numbers 415-00726 and above have been modified during production. This modification does not require recalibration of the Model 3440A.

5-54. DC ISOLATION (Model 3440A Below Serial Number 347-00301).

5-55. This modification raises the dc isolation voltage of the above instruments from 400 volts to 500 volts above chassis ground. Change the heat sink insulator used with Q1 to a new heat sink, insulator stock number 1200-0091. This can be purchased from your local Field Sales and Service Office.

5-56. MODIFICATION PROCEDURE.

- a. Refer to Figure 5-6; remove Transistor Q1 and its insulator--taking care to not lose the mounting stud insulators.
- b. File the emitter and base holes $1/8"$ larger in a direction as shown in Figure 5-6. Be sure to deburr and smooth the filed portion of the hole to

insure against any shorting of the new insulator to the chassis.

c. Install the new insulator block with the red side making contact with the 3440A chassis. Position the insulator so that it does not interfere with the grommet containing the transformer wires. (If the insulator overlaps the wiring grommet, it will not make good thermal contact with the 3440A chassis.)

d. Install Q1. Rotate it 180° from its original orientation so that the emitter is now in the hole nearest A9 receptacle. Be sure to use the stud insulators removed in step a.

e. Turn the instrument bottom side up and rotate Q1 socket 180° . It may be necessary to install longer wires from A9 receptacle to Q1 socket. Refer to Figure 5-6 for the proper wire colors and connections.

f. This modification does not require recalibration of the Model 3440A.

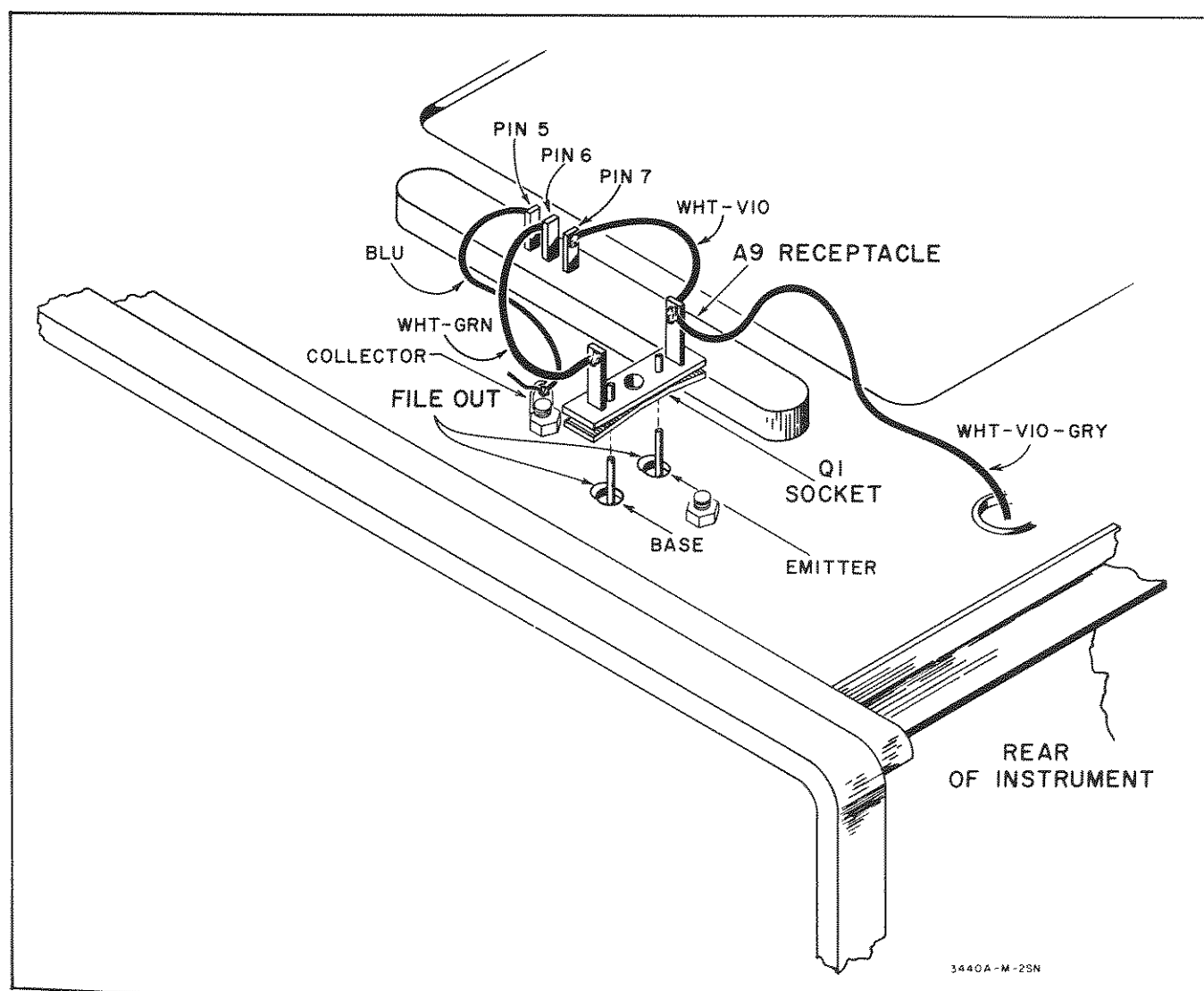
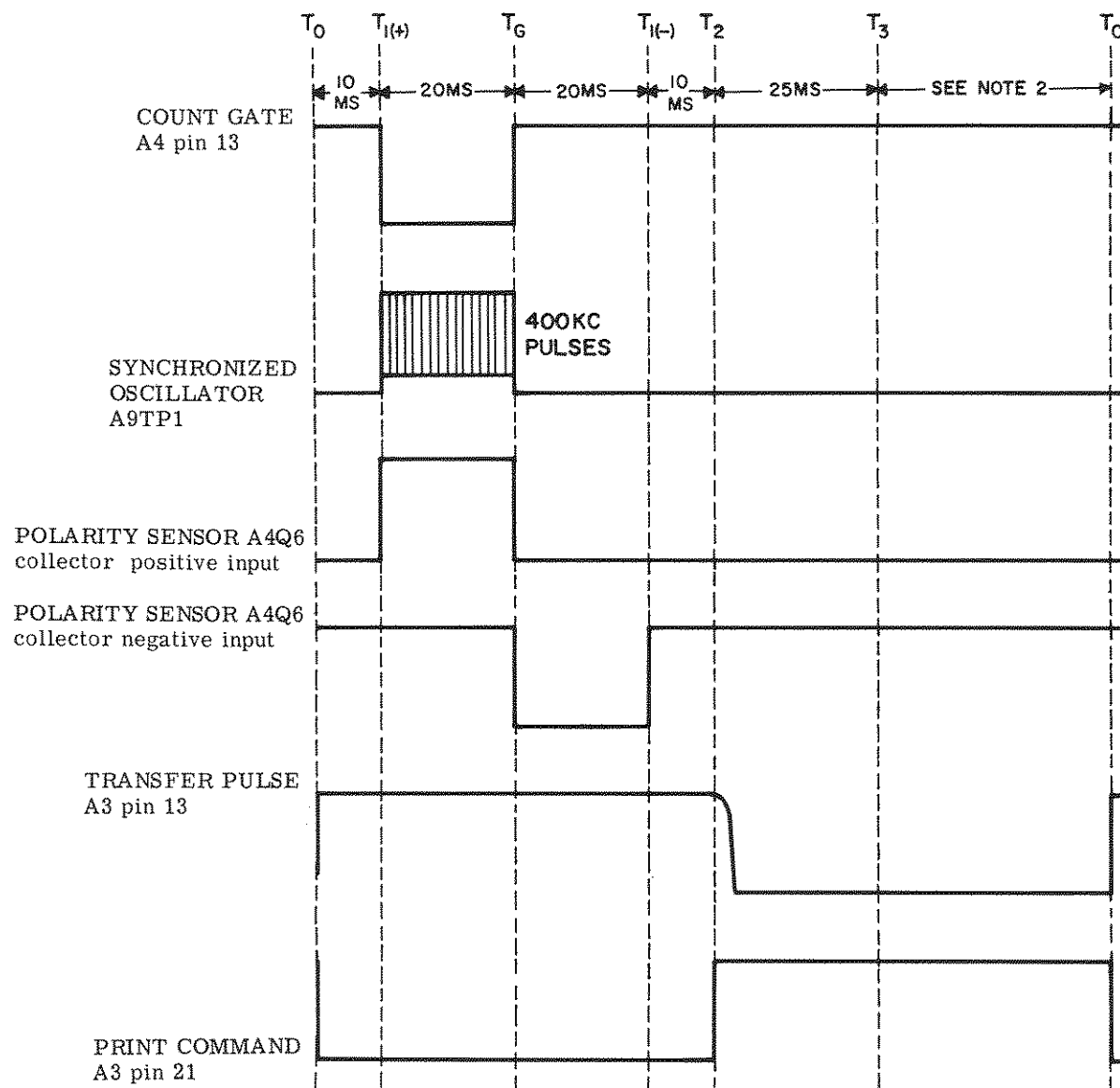


Figure 5-6. DC Isolation Increase Modification



NOTES

1. TIME INTERVAL BETWEEN TIMES T_1 and T_G IS DETERMINED BY INPUT VOLTAGE LEVEL (8.000 VOLTS SHOWN).
2. TIME INTERVAL GOING FROM TIME T_3 TO TIME T_0 IS DETERMINED BY SAMPLE RATE CONTROL SETTING.
3. REFER TO FIGURE 5-8 FOR VOLTAGE LEVELS OF WAVEFORMS.

3440A-8-0025

Figure 5-7. Waveform Time Sequence

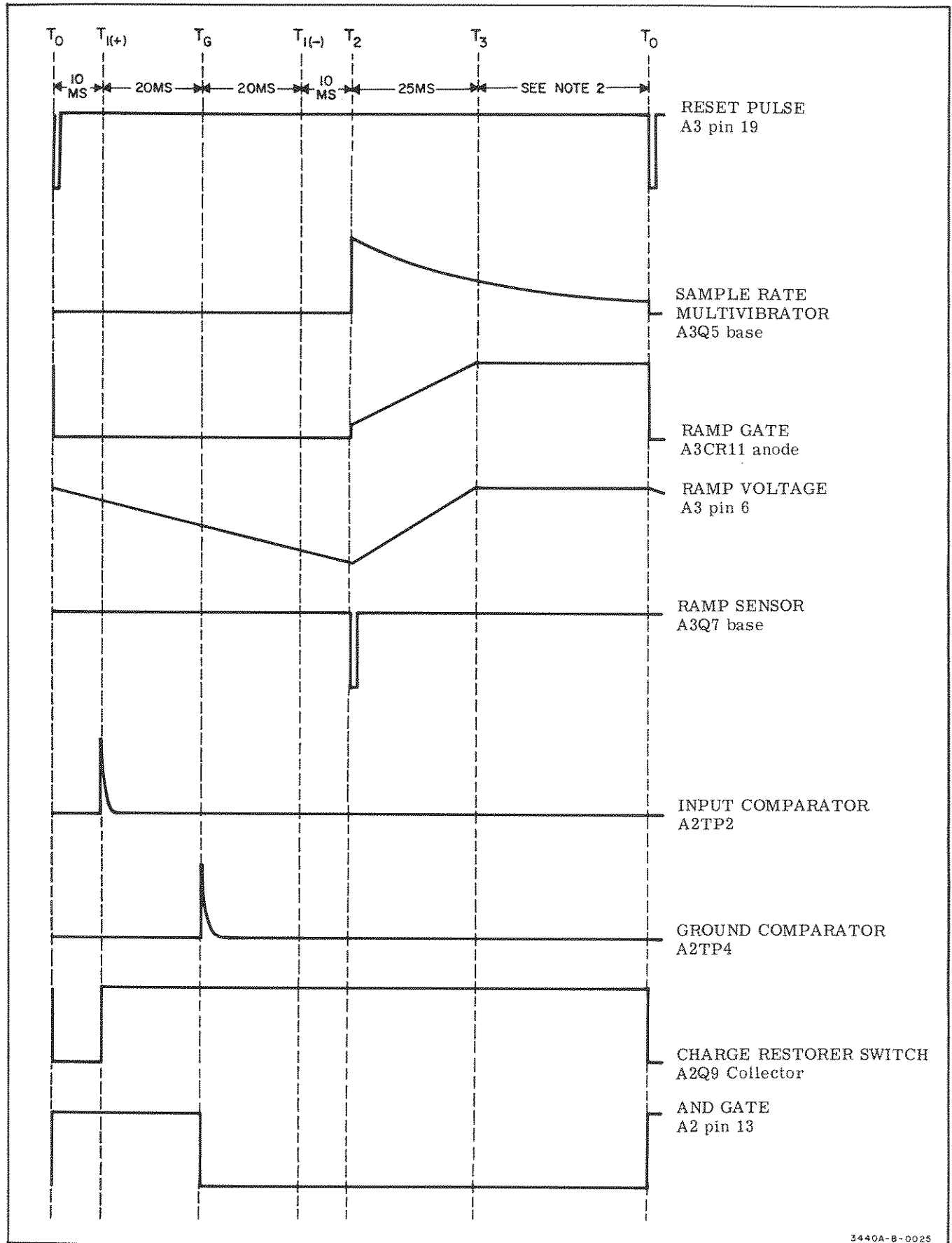
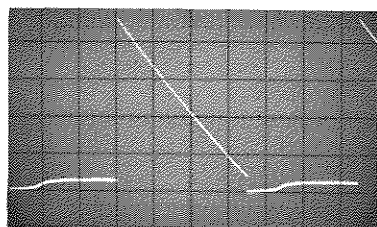
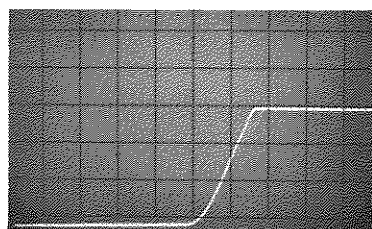


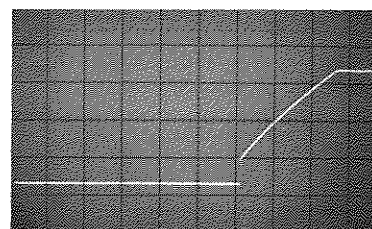
Figure 5-7. Waveform Time Sequence (cont'd)



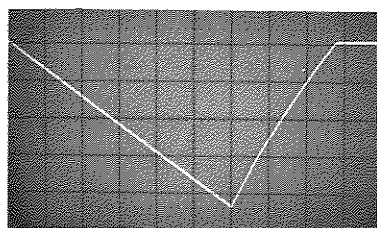
A - SAMPLE RATE
MULTIVIBRATOR
A3Q5 base
1.0 volt/cm; 20 msec/cm



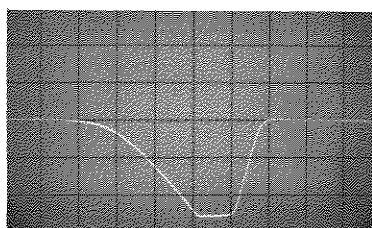
B - RESET PULSE
A3 (19)
10 volts/cm; 5 μ sec/cm



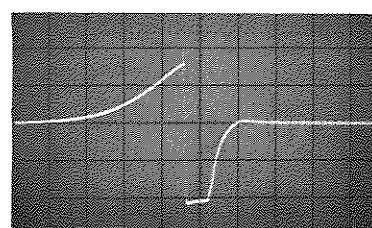
C - RAMP GATE
A3CR11 anode
10 volts/cm; 10 msec/cm



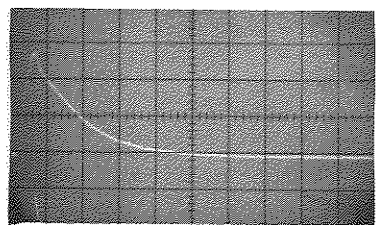
D - RAMP
A3 (6)
5.0 volts/cm; 10 msec/cm



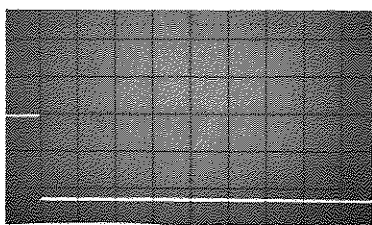
E - RAMP SENSOR
A3Q7 base
5.0 volts/cm; 2.0 msec/cm
time T_2



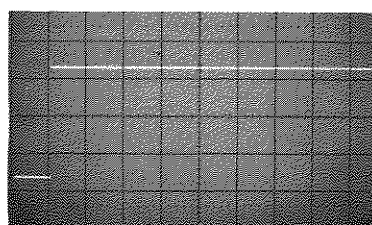
F - INPUT AMPLIFIER
A2TP1
5.0 volts/cm; 0.1 msec/cm
time T_i ; AC coupled



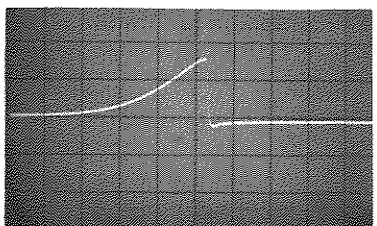
G - INPUT PULSE
A2TP2
5.0 volts/cm; 0.5 μ sec/cm
time T_i ; AC coupled



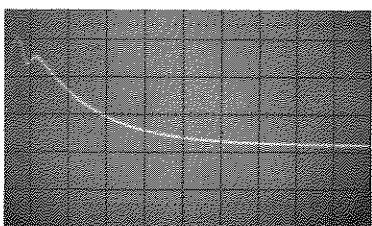
H - INPUT FLIP-FLOP
A2Q7 collector
10 volts/cm; 10 msec/cm



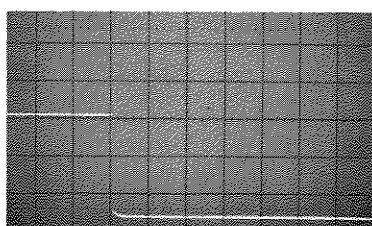
J - CHARGE RESTORER SWITCH
A2Q9 collector
10 volts/cm; 10 msec/cm



K - GROUND AMPLIFIER
A2TP3
5.0 volts/cm; 0.1 msec/cm
time T_g ; AC coupled



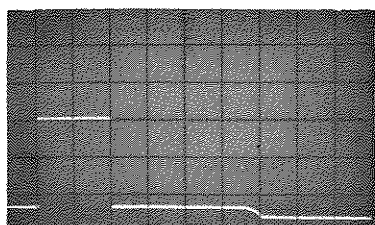
L - GROUND PULSE
A2TP4
5.0 volts/cm; 0.5 μ sec/cm
time T_g ; AC coupled



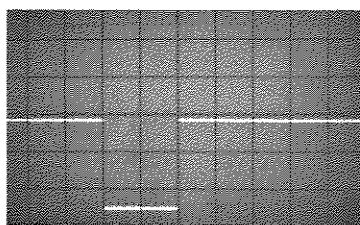
M - GROUND FLIP-FLOP
A2Q15 collector
10 volts/cm; 10 msec/cm

NOTE: Each waveform starts at T_0 unless otherwise stated.

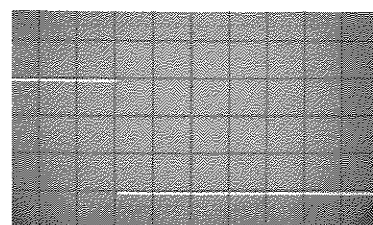
Figure 5-8. Typical Waveforms



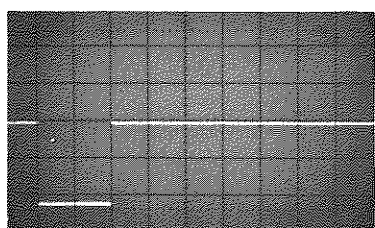
N - POLARITY SENSOR
A4Q6 collector
10 volts/cm; 10 msec/cm



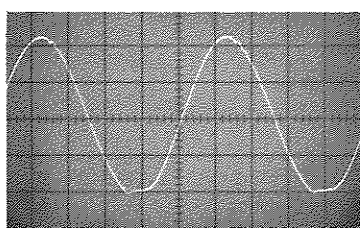
P - POLARITY SENSOR
A4Q6 collector
10 volts/cm; 10 msec/cm
-8.000 volt input



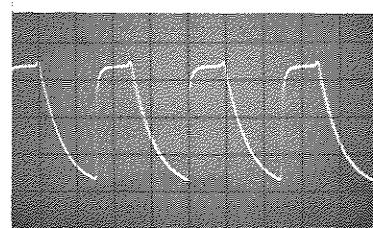
Q - AND GATE
A2 (15)
5.0 volts/cm; 10 msec/cm



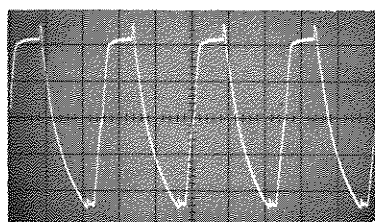
R - COUNT GATE
A4Q2 collector
10 volts/cm; 10 msec/cm



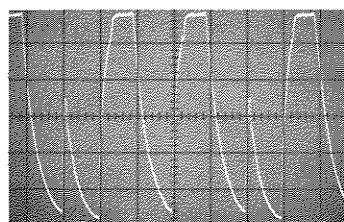
S - SYNCHRONIZED OSCILLATOR
A9Q5 collector
5.0 volts/cm; 5.0 μ sec/cm
AC coupled



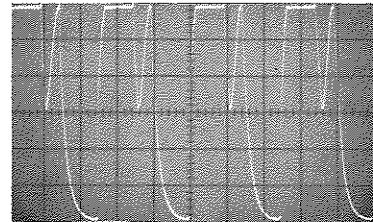
T - SYNCHRONIZED OSCILLATOR
A9TP1
10 volts/cm; 1.0 μ sec/cm
AC coupled



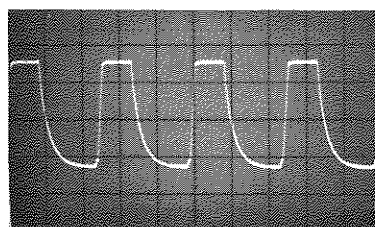
U - UNITS DECADE COUNTER
A5Q1 collector
5.0 volts/cm; 2.0 μ sec/cm
AC coupled



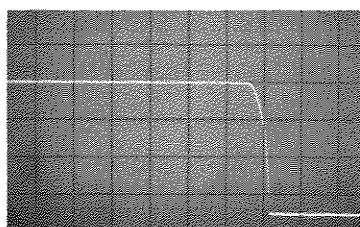
V - UNITS DECADE COUNTER
A5Q3 collector
5.0 volts/cm; 5.0 μ sec/cm
AC coupled



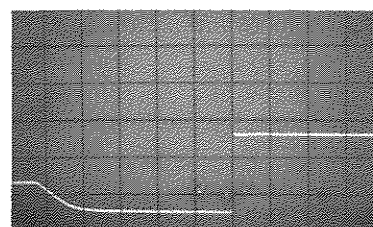
W - UNITS DECADE COUNTER
A5Q5 collector
5.0 volts/cm; 10 μ sec/cm
AC coupled



X - UNITS DECADE COUNTER
A5 (10)
10 volts/cm; 10 μ sec/cm
AC coupled



Y - TRANSFER PULSE
A3 (13)
10 volts/cm; 10 msec/cm



Z - PRINT COMMAND
A3 (21)
5.0 volts/cm; 10 msec/cm

Figure 5-8. Typical Waveforms (cont'd)

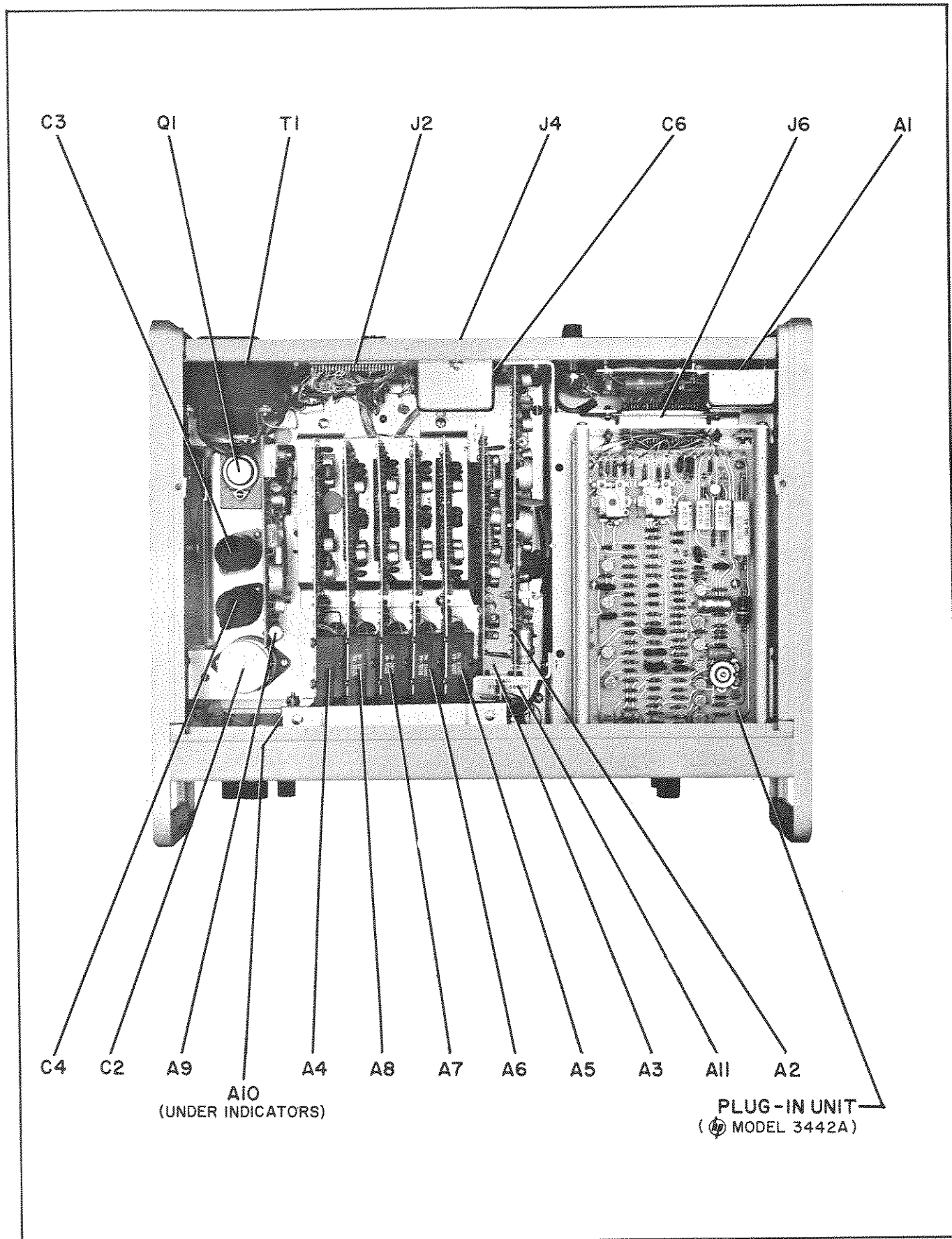
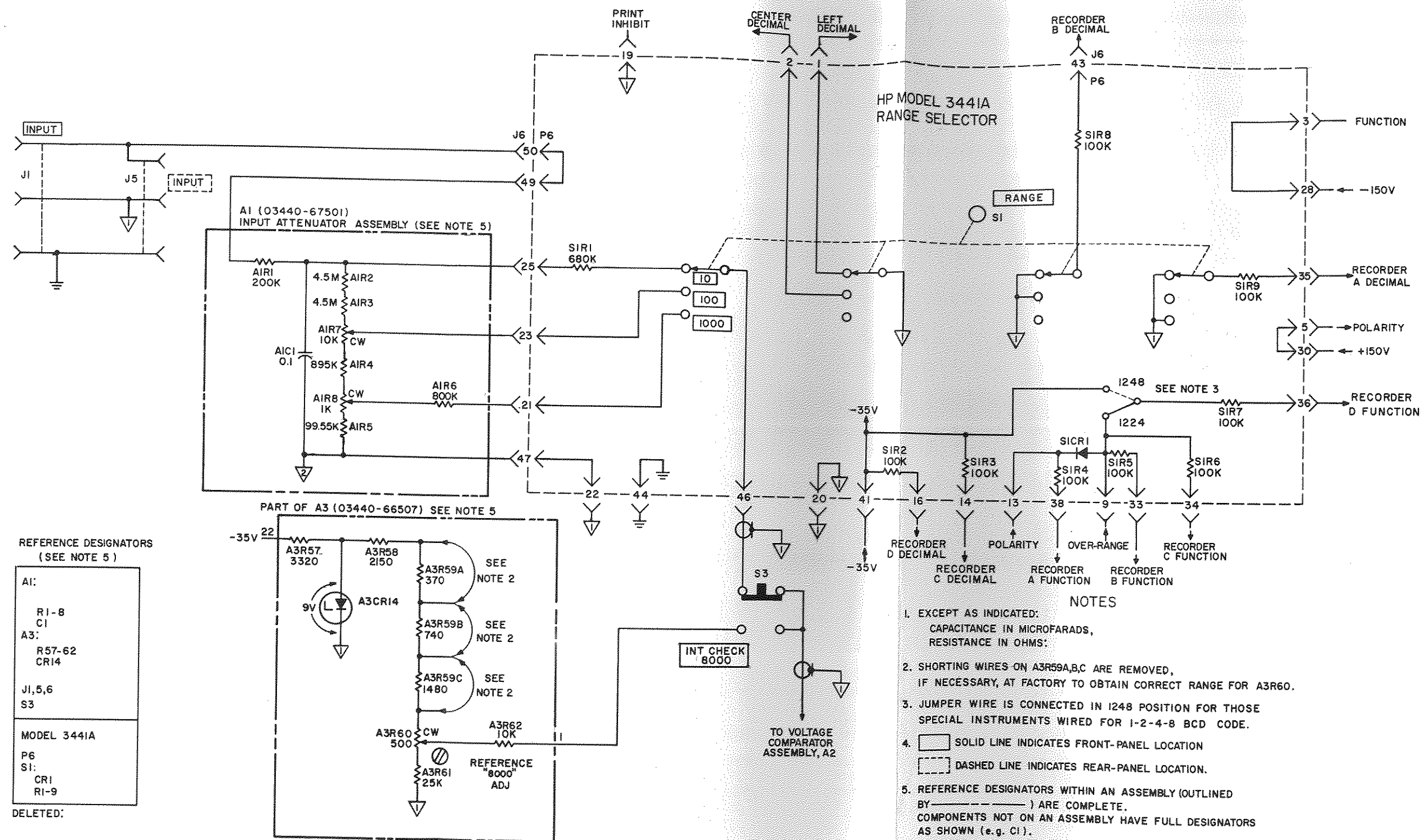


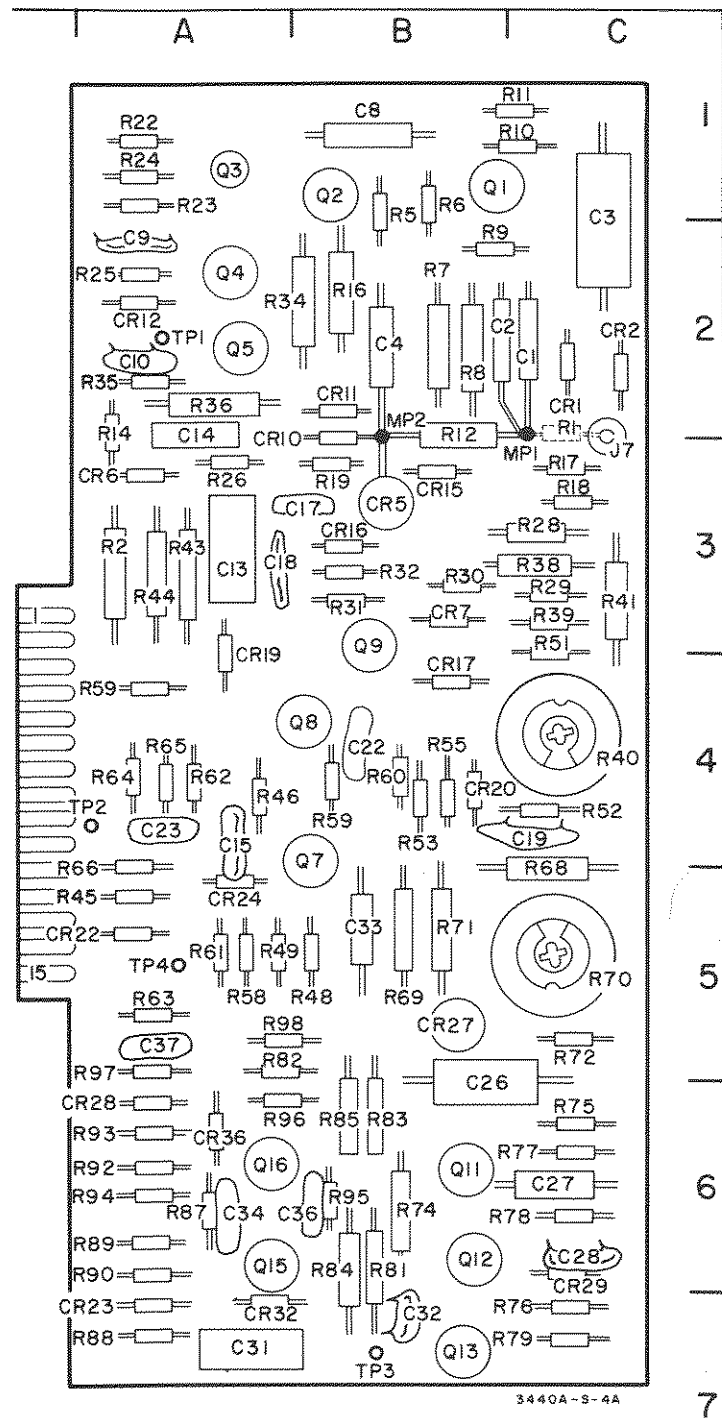
Figure 5-9. Chassis - Top View



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NOTES

1. EXCEPT AS INDICATED:
CAPACITANCE IN MICROFARADS,
RESISTANCE IN OHMS:
2. SHORTING WIRES ON A3R59A,B,C ARE REMOVED,
IF NECESSARY, AT FACTORY TO OBTAIN CORRECT RANGE FOR A3R60.
3. JUMPER WIRE IS CONNECTED IN 1248 POSITION FOR THOSE
SPECIAL INSTRUMENTS WIRED FOR 1-2-4-8 BCD CODE.
4.  SOLID LINE INDICATES FRONT-PANEL LOCATION
 DASHED LINE INDICATES REAR-PANEL LOCATION.
5. REFERENCE DESIGNATORS WITHIN AN ASSEMBLY (OUTLINED
BY ————) ARE COMPLETE.
COMPONENTS NOT ON AN ASSEMBLY HAVE FULL DESIGNATORS
AS SHOWN (e.g. C1).
6. COMPONENTS WITHIN HEAVY DASHED LINE (———) ARE
LOCATED ON MODEL 3441A PLUG-IN UNIT.
7.  INDICATES SIGNAL GROUND.
 INDICATES ATTENUATOR GROUND.
 INDICATES CHASSIS GROUND.



A2 Location of Components

	C	CR	Q	R	TP		R
1	C2, C3	C2, D1	B1, C2	C3, B3	A1, G1	50	
2	B2, C2	C2, D1	B1, D2	A3, C3	A4, L2	51	C3, G3
3	C1, D2		A1, E2		B7, F4	52	C4, H3
4	B2, D2		A2, E2		A5, L5	53	B4, J3
5		B3, D3	A2, F2	B1, C1		54	A4, J4
6		A3, D3		B1, C1		55	B4, H3
7		B3, E2	B4, H1	B2, C2		56	
8	B1, E2		B4, K1	B2, C2		57	
9	A2, F2		B3, G4	B2, C2		58	A5, K1
10	A2, F2	B3, D3		C1, D2		59	B4, K1
11		B2, E3	B6, D5	C1, D2		60	B4, K1
12		A2, F2	B6, E5	B3, C3		61	A5, K2
13	A3, G1		B7, E5			62	A4, A2
14	A2, G2			A2, D4		63	A5, K2
15	A4, H1	B3, E3	A6, G5			64	A4, B1
16		B3, F3	A6, J5	B2, E2		65	A4, B2
17	B3, F3	B4, G3		C3, E3		66	A5, B2
18	A3, G3			C3, E3		67	
19	C4, H3	A4, G1		B3, E3		68	C5, B5
20		B4, H3				69	B5, B6
21						70	C5, B6
22	B4, K1	A5, J2		A1, E1		71	B5, B5
23	A4, K2	A7, J2		A1, F1		72	C5, C5
24		A5, J2		A1, F2		73	
25				A2, F2		74	B6, D5
26	B6, C5			A3, F1		75	C6, D5
27	C6, D5	B5, B5				76	C7, E5
28	C6, E5	A6, E6		C3, E3		77	C6, E5
29		C6, E5		C3, E3		78	C6, E5
30				B3, F3		79	C7, E5
31	A7, F5			B3, F3		80	
32	B7, F5	A7, G5		B3, G3		81	B6, F5
33	B5, F6					82	A5, F6
34	A6, G4			B2, G2		83	B6, F6
35				A2, G2		84	B6, F5
36	B6, J4	A6, J5		A2, G2		85	B6, F5
37	A5, K5					86	
38				C3, E2		87	A6, G4
39				C3, F2		88	A7, G4
40						89	A6, G5
41				C4, G2		90	A6, G5
42				C3, G2		91	
43				A3, G1		92	A6, H5
44				A3, G2		93	A6, H6
45				A5, H2		94	A6, J4
46				A4, H1		95	B6, J4
47				A5, H2		96	A6, J5
48				B5, H1		97	A5, K5
49						98	A5, K5

"Location Chart for A2"

Notes

1. The letters at the top of the chart designate type of component.
2. The number column completes the designator. Example, 1 under C is C1 and 1 under CR is CR1.
3. The first grid location is for Board A2, Figure 5-11. The second grid location is for Schematic of A2, Figure 5-12. Example, Q5 has a grid location of A2 on the board and F2 on the schematic.

Figure 5-11. A2 Location of Components and Chart

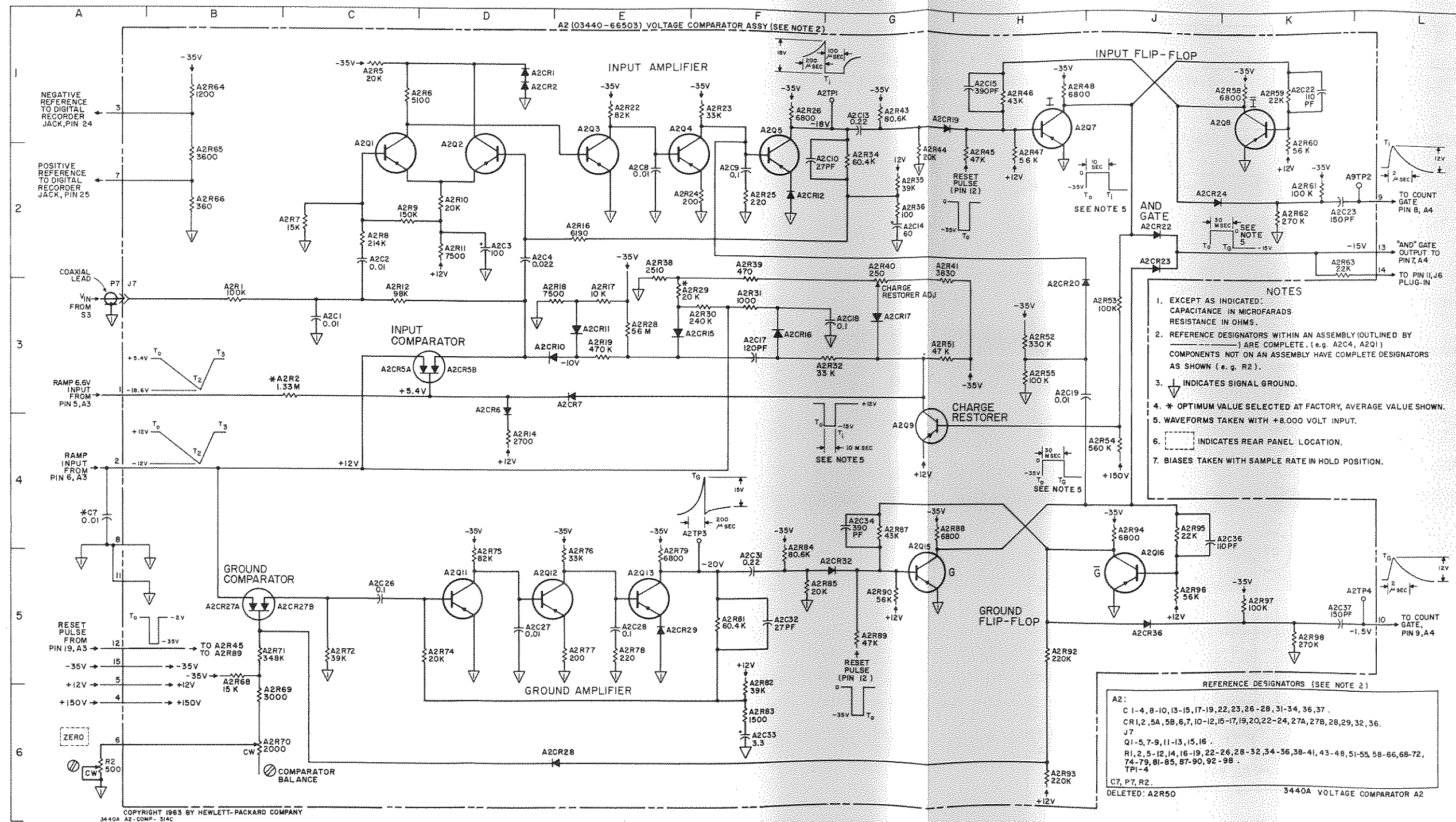
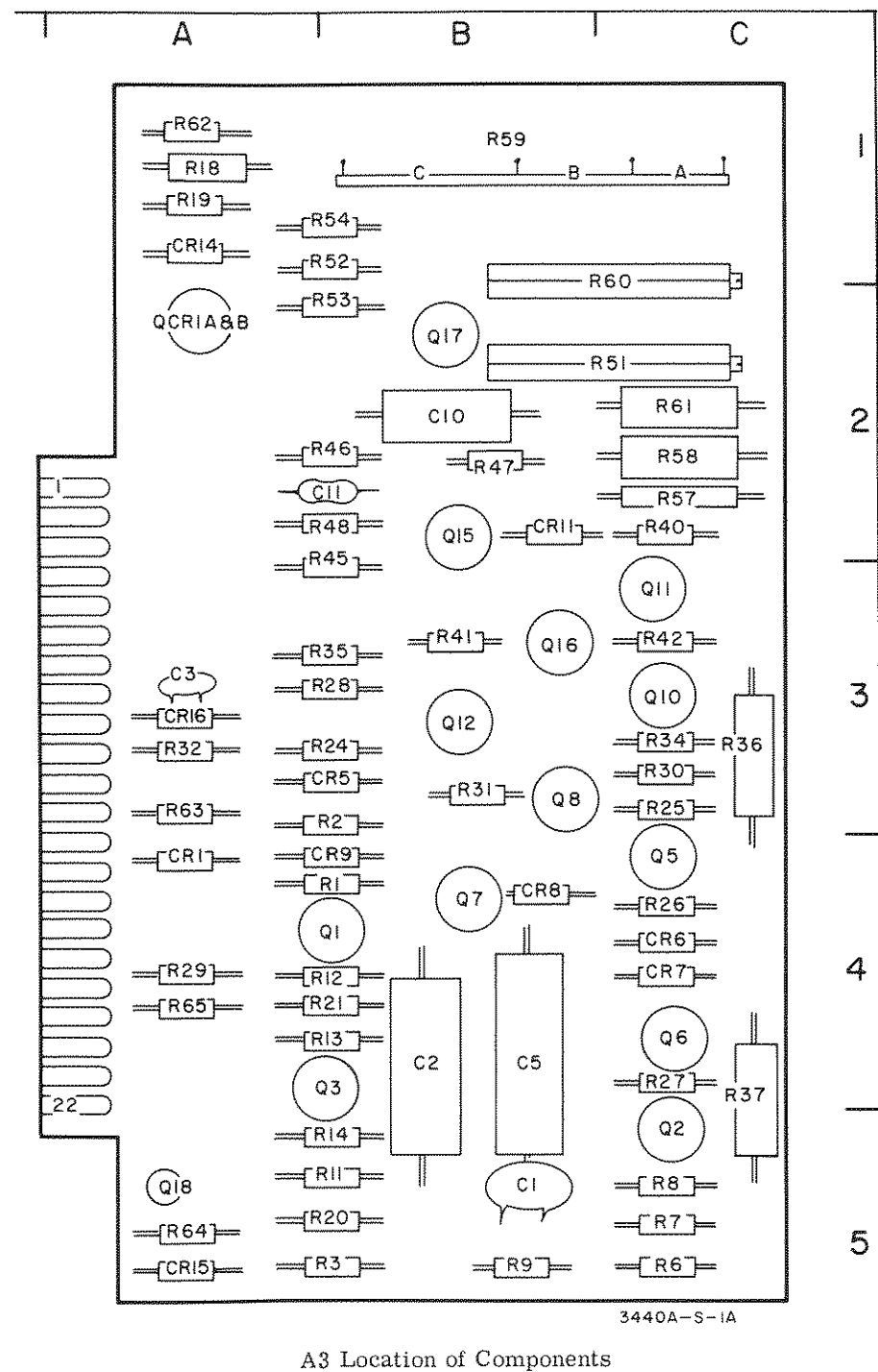


Figure 5-12. (A2) Voltage Comparator



A3 Location of Components

	C	CR	Q	R		R		R
1	B5, C1	A4, B2	B4, B2	B4, B1	23		45	B3, G1
2	B4, D2		C5, C2	B3, B1	24	B3, D3	46	B2, H2
3	A3, E4		B4, D1	B5, B2	25	C3, D3	47	B2, H2
4					26	C4, E3	48	B2, J1
5	B4, C3	B3, C3	C4, D3		27	C4, E3	49	
6		C4, D4	C4, E3	C5, C1	28	B3, E4	50	
7		C4, D4	B4, D4	C5, C1	29	A4, E3	51	C2, H3
8		B4, D4	B3, F4	C5, C3	30	C3, F4	52	B1, J3
9		B4, E3		B5, C2	31	B3, F4	53	B2, J4
10	B2, G2		C3, F3		32	A3, F4	54	B1, J4
11	B2, G2	B2, F2	C3, F2	B5, D1	33		55	
12			B3, G2	B4, D1	34	C3, E3	56	
13				B4, D1	35	B3, F3	57	C2, --
14		A1, --		B5, D2	36	C3, F3	58	C2, --
15			B2, H2		37	C4, F3	59	C1, --
16		A3, D2	B3, J2		38		60	C1, --
17			B2, J3		39		61	C2, --
18			A5, D2	A1, B4	40	C2, F1	62	A1, --
19				A1, B5	41	B2, F2	63	A3, D2
20				B5, C4	42	C3, G1	64	A5, D2
21				B4, C4	43		65	A4, D2
22					44			

NOTE
First grid location is for Board, Figure 5-13.
Second grid location is for Schematic, Figure 5-14.

Figure 5-13. A3 Location
of Components and Chart

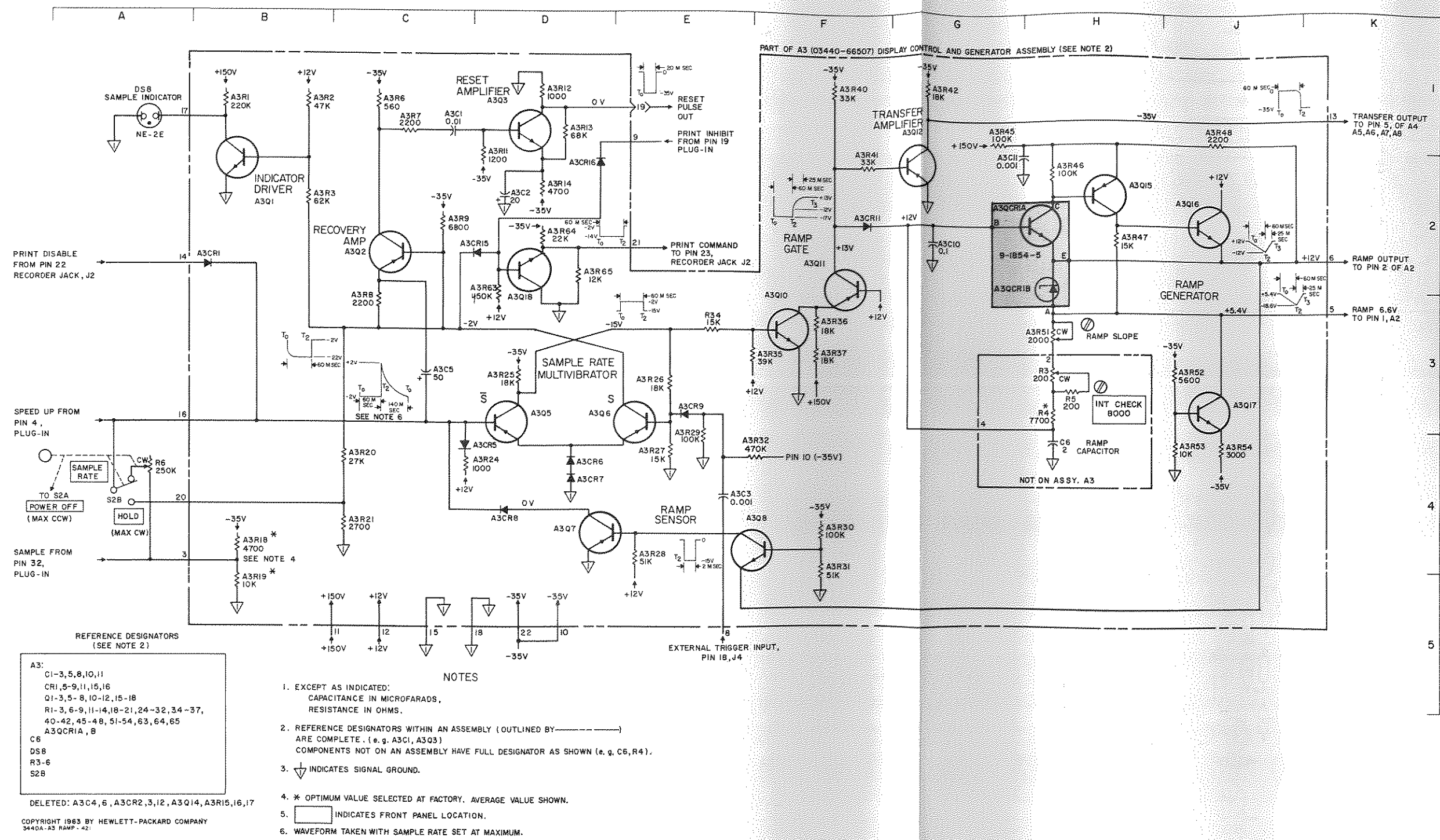
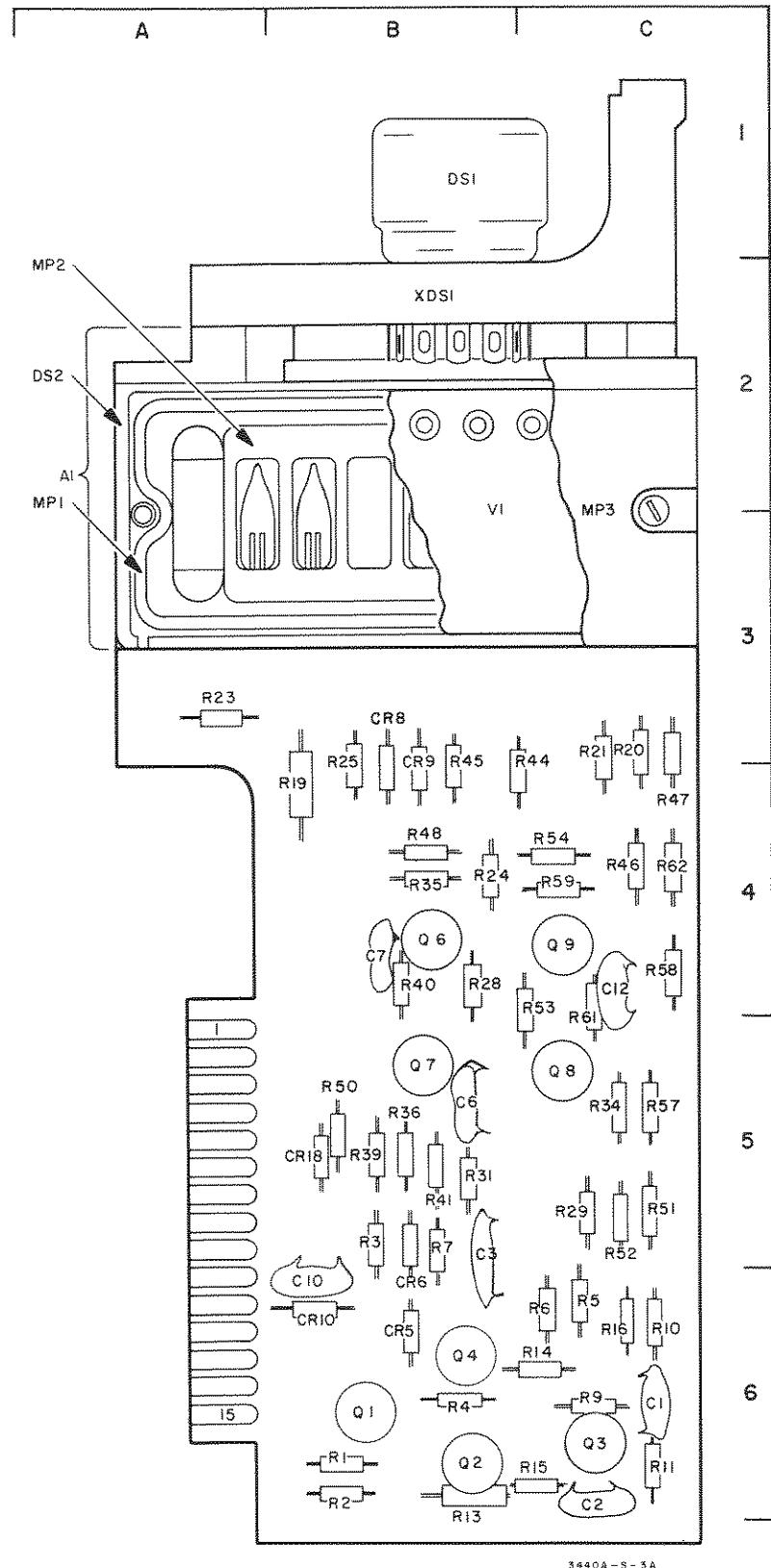


Figure 5-14. (A3) Ramp Generator



A4 Location of Components

Figure 5-15. A4 Location
of Components and Chart

	C	CR	Q	R		R
1	C6, B2		B6, B1	B6, A1	32	
2	C6, D2		B6, C2	B6, B1	33	
3	B5-6, C3		C6, D2	B5-6, B1	34	C5, B4
4			B6, C2	B6, B2	35	B4, C4
5		B6, C3		C6, B2	36	B5, C5
6	B5, B4	B5-6, C3	B4, B5	C6, B2	37	
7	B4, C4		B5, C5	B5-6, B2	38	
8		B3-4, B4	C5, E5		39	B5, C5
9		B3-4, C4	C4, F5	C6, B2	40	B4, C4
10	B5-6, D5	B6, D5		C6, C2	41	B5, C5
11				C6, C1	42	
12	C4-5, F4				43	
13				B6, C1	44	B-C-3-4, E4
14				C6, C2	45	B3-4, F3
15				C6, D2	46	C4, F4
16				C6, D2	47	C3-4, F3
17					48	B4, F4
18		B5, F4			49	
19				B3-4, B2	50	B5, F4
20				C3-4, B3	51	C5, D5
21				C3-4, C3	52	C5, D5
22					53	C4-5, E4
23				A3, C3	54	C4, E5
24				B4, B4	55	
25				B3, C4	56	
26					57	C5, E4
27					58	C4, F4
28				B4-5, B4	59	C4, E5
29				C5, B5	60	
30					61	C4-5, F4
31				B5, B5	62	C4, F5

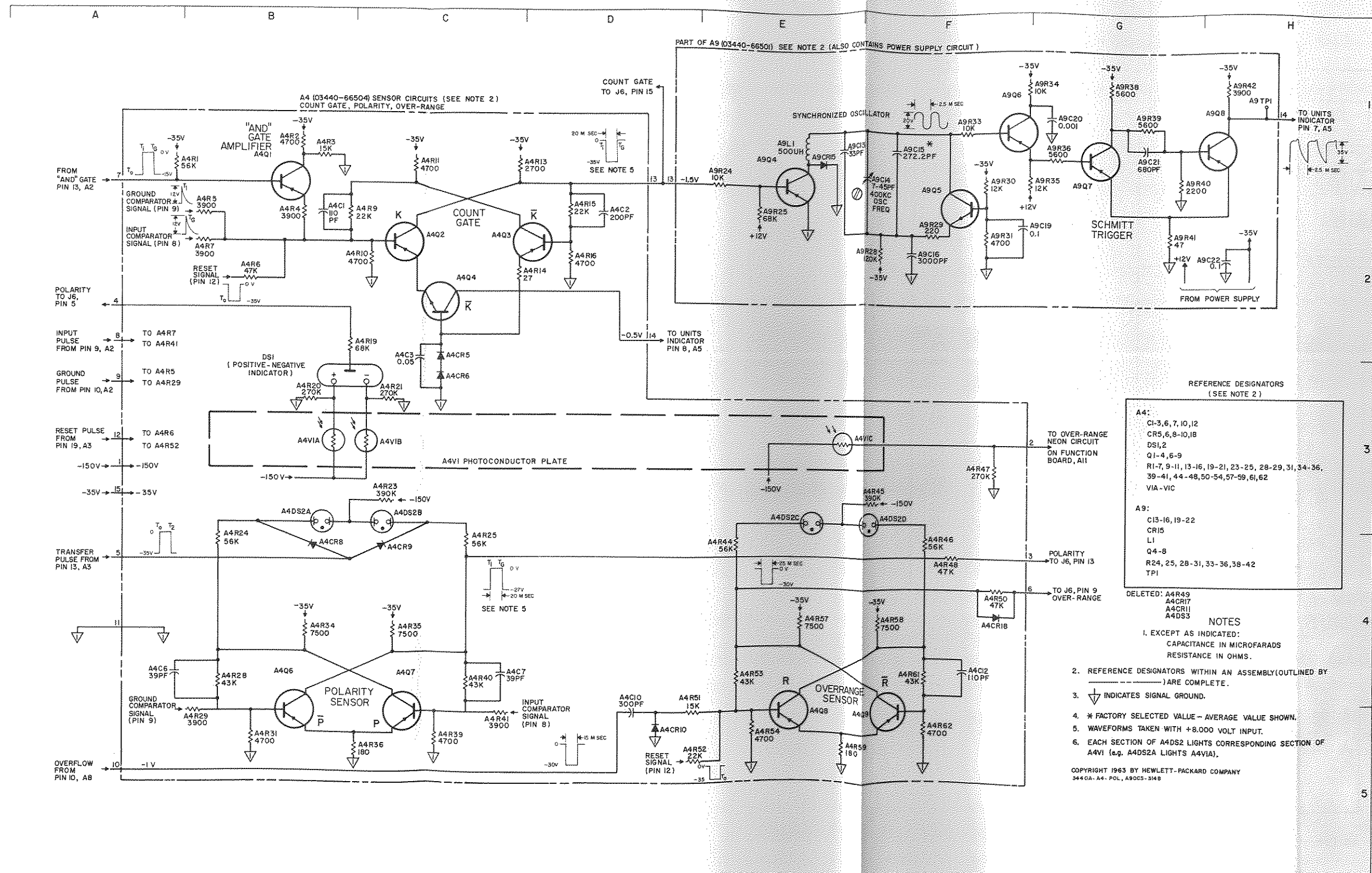
	DS
1	B1, B3
2A	A2-3, B3
2B	B2-3, C3
2C	B2-3, E3
2D	C2-3, F3

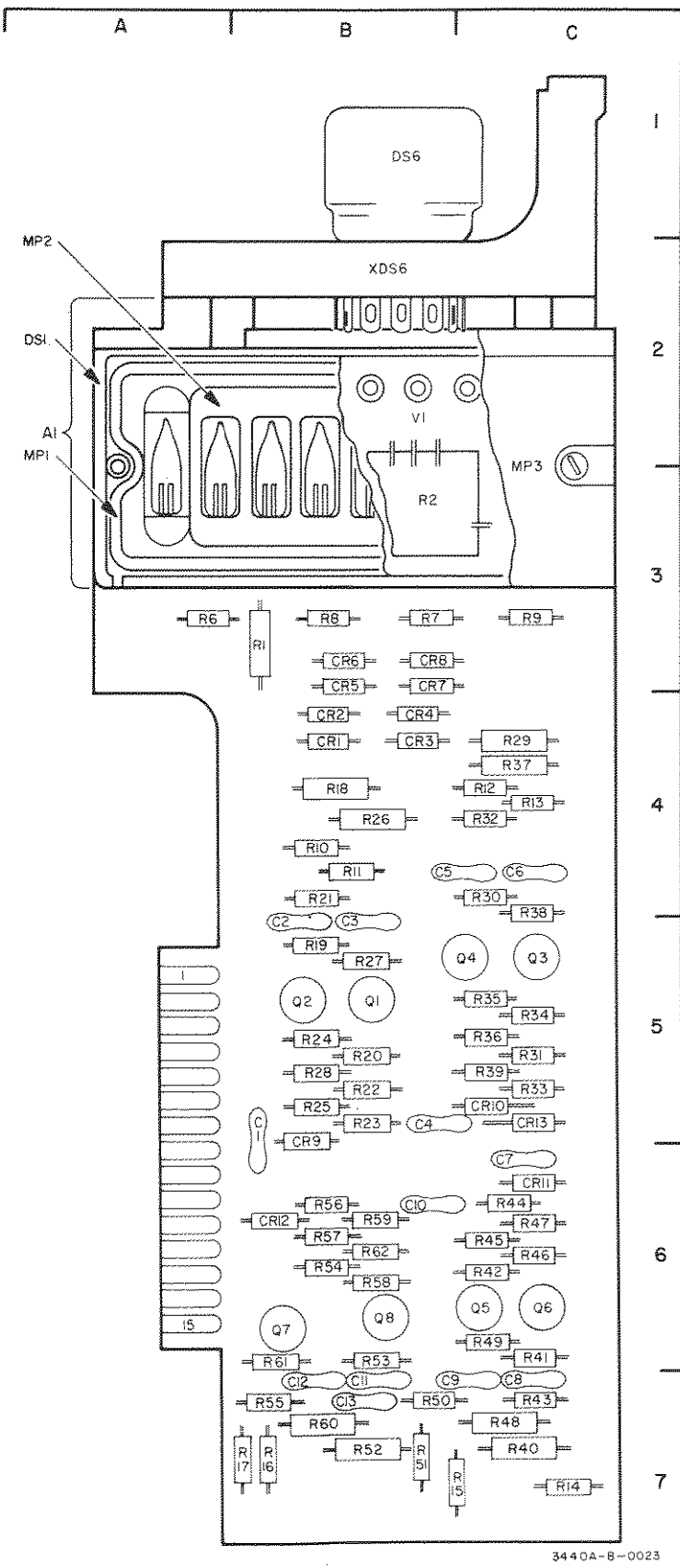
	V
1A	B2, B3
1B	B2, C3
1C	B2, E3

Note
First grid location is for Board, Figure 5-15.
Second grid location is for Schematic, Figure 5-16.

	C	CR	L	Q	TP
1			--, E1		--, H1
2					
3					
4				--, E1	
5				--, F2	
6				--, F1	
7				--, G1	
8				--, H1	
9					
10					
11					
12					
13	--, F1				
14	--, F1				
15	--, F1	--, E1			
16	--, F2				
17					
18					
19	--, F2				
20	--, G1				
21	--, G1				

	C	R
22	--, H2	
23		
24		--, E1
25		--, E2
26		
27		
28		--, F2
29		--, F2
30		--, F1
31		--, F2
32		
33		--, F1
34		--, F1
35		--, F1
36		--, G1
37		
38		--, G1
39		--, G1
40		--, G1
41		--, G2
42		--, H1





	R		R
1	B3, H1	32	--, C3
2	B2-3, G1	33	C5, C4
3		34	C5, C3
4		35	C5, C3
5		36	C5, D3
6	A3, B2	37	C4, C2
7	B3, C2	38	C4-5, D3
8	B3, E2	39	C5, D3
9	C3, G2	40	C7, E2
10	B4, A2	41	C6, D3
11	B4, B2	42	C6, D3
12	C4, C2	43	C7, --
13	C4, D2	44	C6, --
14	--, E2	45	C6, E3
15	B-C7, E2	46	C6, E3
16	B7, F2	47	C6, E3
17	A7, G2	48	C7, E2
18	B4, B2	49	C6, E3
19	B4-5, A3	50	B-C7, E3
20	B5, A3	51	B7, F4
21	B4-5, A3	52	B7, F2
22	B5, A3	53	B5-7, F3
23	B5, B4	54	B6, F3
24	B5, B3	55	B7, F4
25	B5, B3	56	B6, F4
26	B4, B2	57	B6, F3
27	B5, B3	58	B6, G3
28	B5, B3	59	B6, G3
29	C4, C2	60	B7, G2
30	C4, C3	61	B6-7, G3
31	C5, C3	62	B6, G3

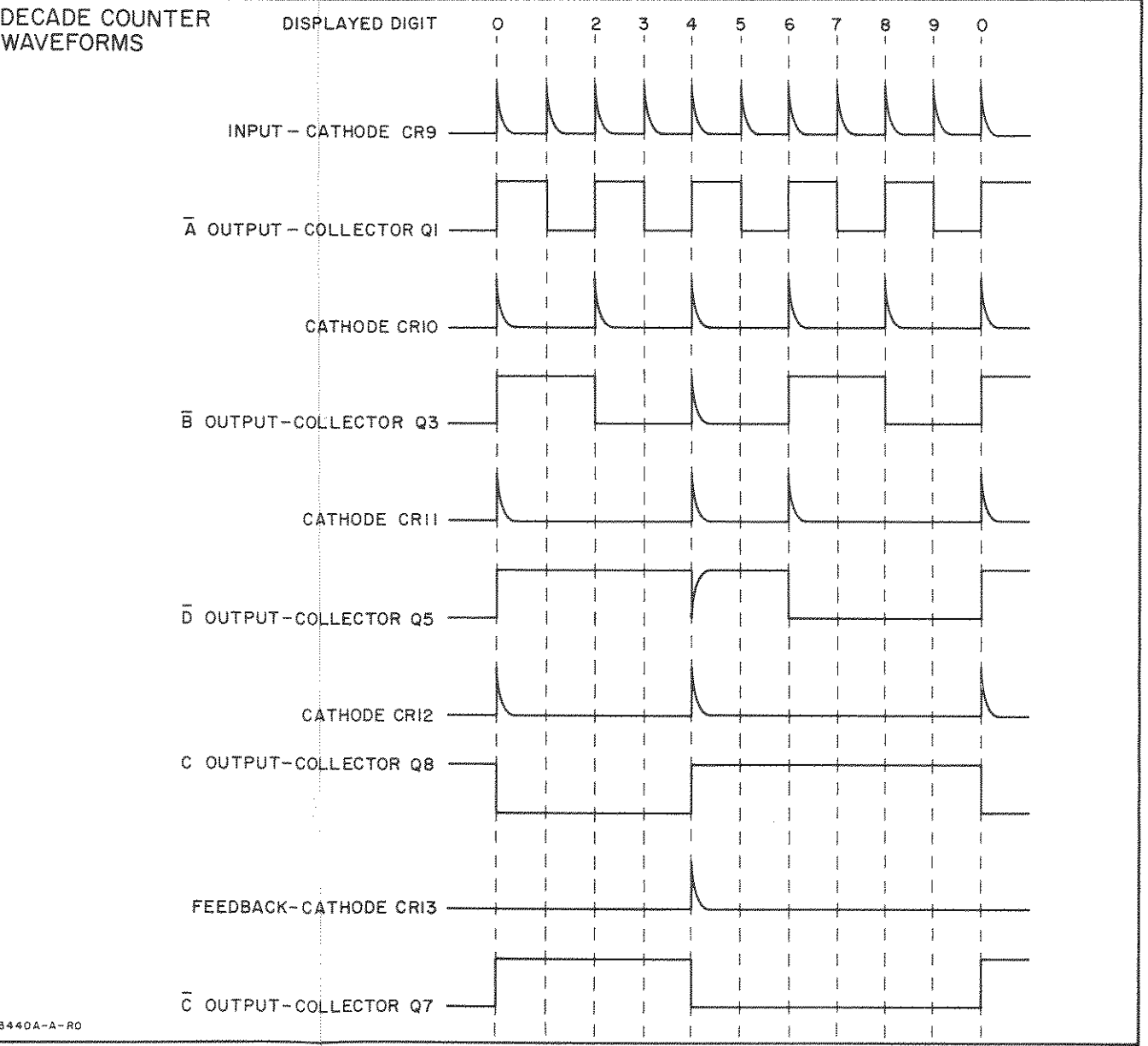
	V		V
1A	A2, B1	1K	B2, E1
1B	A2, B2	1L	B2, E1
1C	A2, B2	1M	B2, E1
1D	A2, B2	1N	B2, E2
1E	B2, C1	1P	C2, F1
1F	B2, C2	1Q	C2, F2
1G	B2, C1	1R	C2, G1
1H	B2, C1	1S	C2, G1
1J	B2, E1	1T	C2, G2

	DS
1A	A2-3, B2
1B	A-B2-3, B2
1C	B2-3, C2
1D	B2-3, C2
1E	B2-3, E2
1F	C2-3, E2
1G	C2-3, F2
1H	C2-3, G2

	C	CR	DS	Q
1	B5-6, A3	B1, A2		B5, B3
2	B4-5, A3	B4, B2		B5, B3
3	B4-5, B3	B4, C2		C5, C3
4	B-C-5-6, C3	B4, D2		B-C5, C3
5	C4, C3	B3-4, D2		B-C6, E3
6	C4, D3	B3, E2	B1, H1	C6, E3
7	C6, D3	B3-4, F2		B6, F3
8	C6-7, D3	B3, G2		B6, G3
9	C6-7, F3	B5-6, A4		
10	B6, F3	C5, C3		
11	B6-7, F3	C6, D3		
12	B6-7, G3	B6, F3		
13	B7, F4	C5, C4		

Note

First grid location is for Board, Figure 5-17.
Second grid location is for Schematic, Figure 5-18.



A5 - A8 Location of Components

Figure 5-17. A5 - A8 Location of Components Wave Shapes and Chart

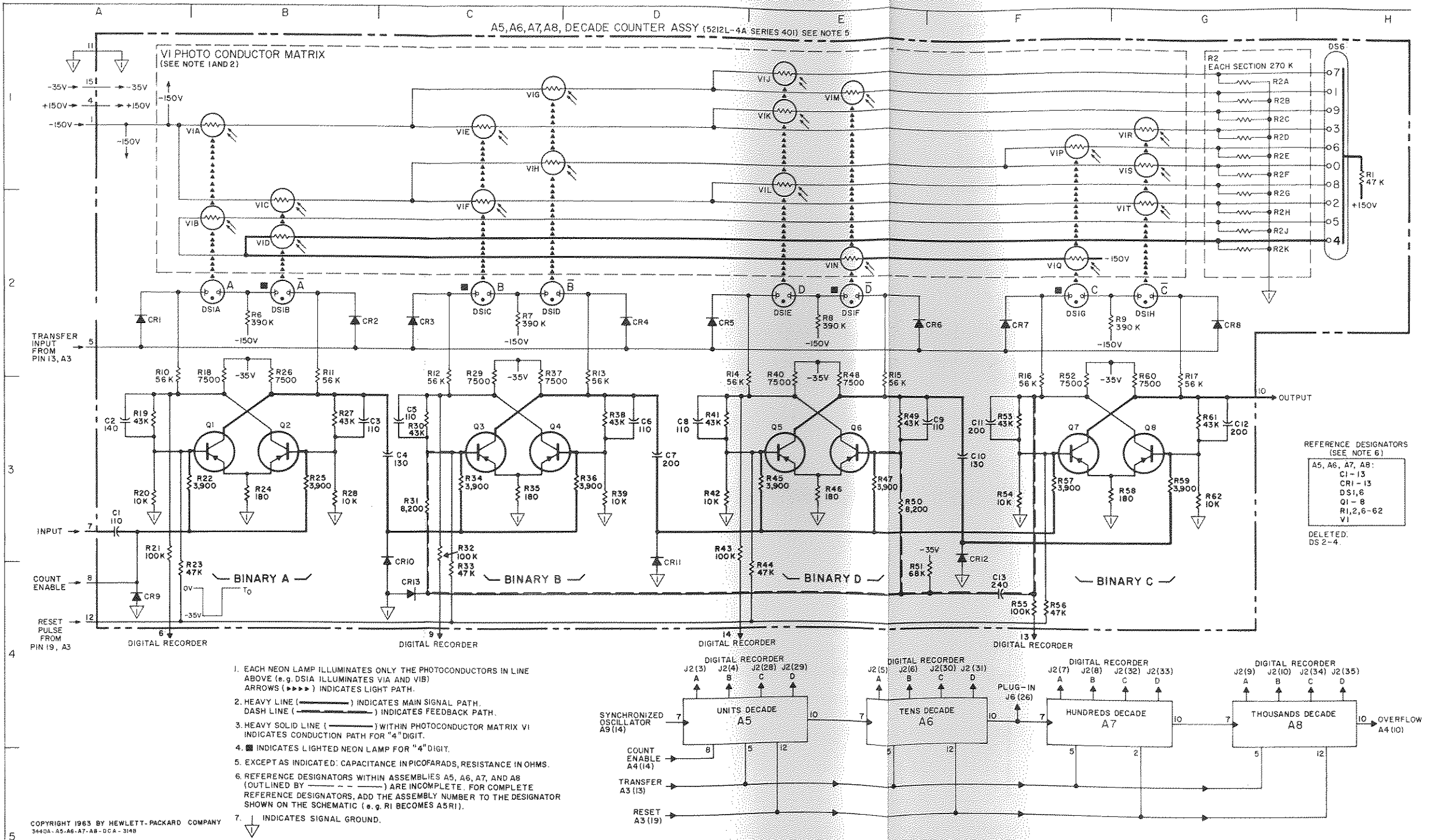
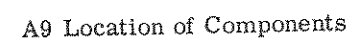


Figure 5-18. (A5 - A8) Decade Counters



01765-1

	C	CR	L	Q	R	TP		C	R
1	B2, D2	A3, D3	B4, --	A2, D1	A1, D1	A5, --	22	A5, --	
2	B2, E2	A4, D3		C2, D2	A1, D1		23		
3	B1, E2	A3, D3			A1, D2		24		
4		A4, D3			C3, --		25		B3, --
5					C4, --		26		
6	A4, D3	A3, C3			B5, --	B1, D2	27		
7	B4, D3	A2, C3			A5, --	B2, D2	28		B5, --
8	B3, D3	A3, C3			A5, --	B1, D2	29		C4, --
9		A2, C3					30		C4, --
10						C1, E2	31		C3, --
11		B2, D2				C3, E2	32		
12		B3, E3				C2, E2	33		B5, --
13	B5, --				B2, E2	34		B5, --	
14	C5, --					35		A4, --	
15	B4, --	B4, --			B4, D3	36		B5, --	
16	B4, --				B4, D3	37			
17						38		A5, --	
18					A2, D3	39		A5, --	
19	C3, --				A2, D3	40		A4, --	
20	B5, --				A3, D3	41		A4, --	
21	A5, --					42		A5, --	

Note

First grid location is for Board, Figure 5-19.
Second grid location is for Schematic, Figure 5-20.

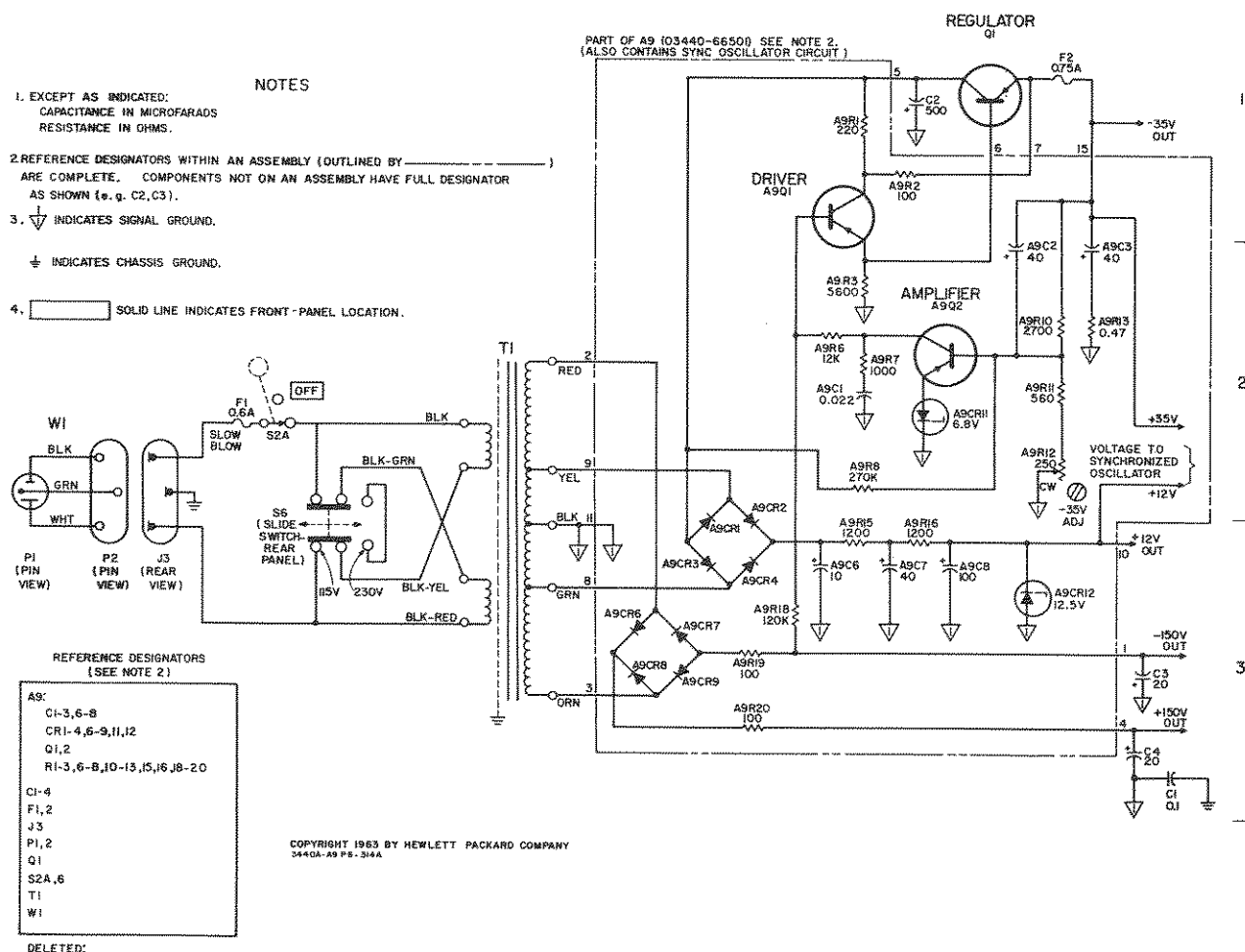
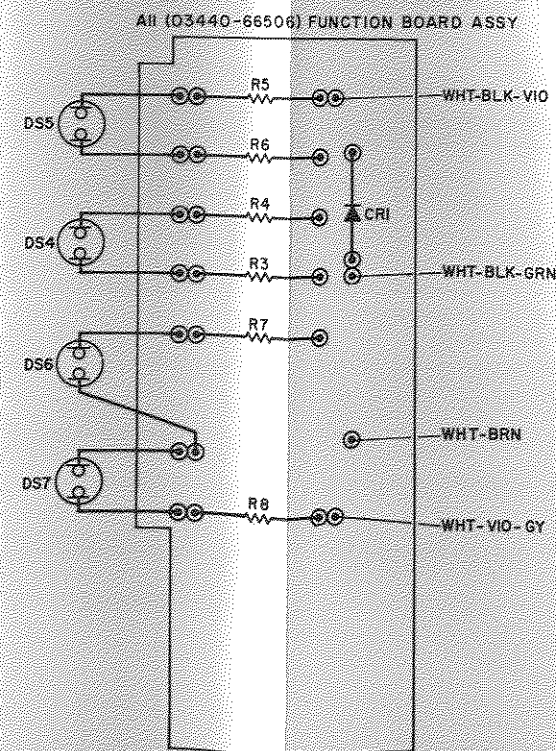
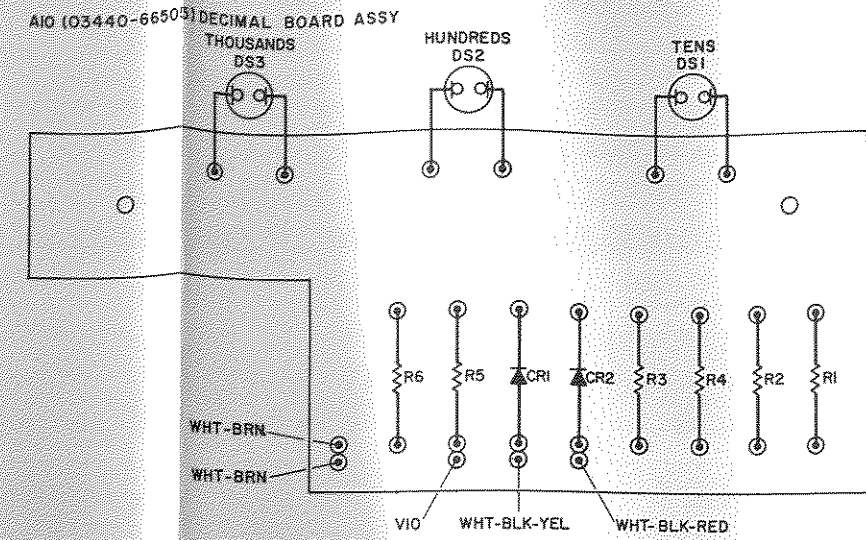
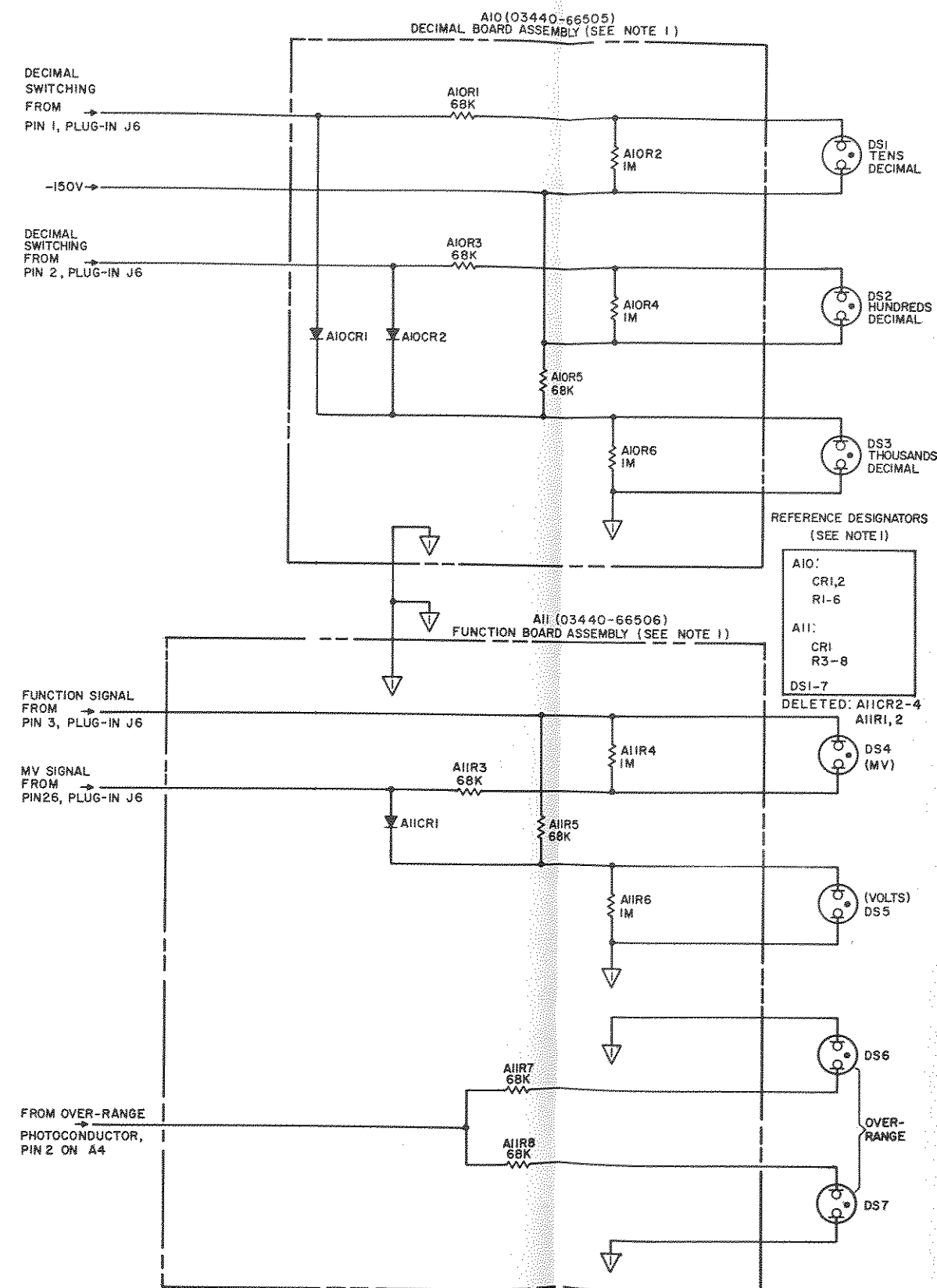


Figure 5-20. (A9) Power Supply



- NOTES
1. REFERENCE DESIGNATORS WITHIN AN ASSEMBLY (OUTLINED BY ---) ARE COMPLETE. COMPONENTS NOT ON AN ASSEMBLY HAVE FULL DESIGNATOR AS SHOWN (DS1-DS7).
 2. ▽ INDICATES SIGNAL GROUND.

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3440A-DEC & FUNCT A10-A11-34B

3440A DECIMAL & FUNCTION
ASSY. A10 - A11

Section V
Figure 5-22

Model 3440A

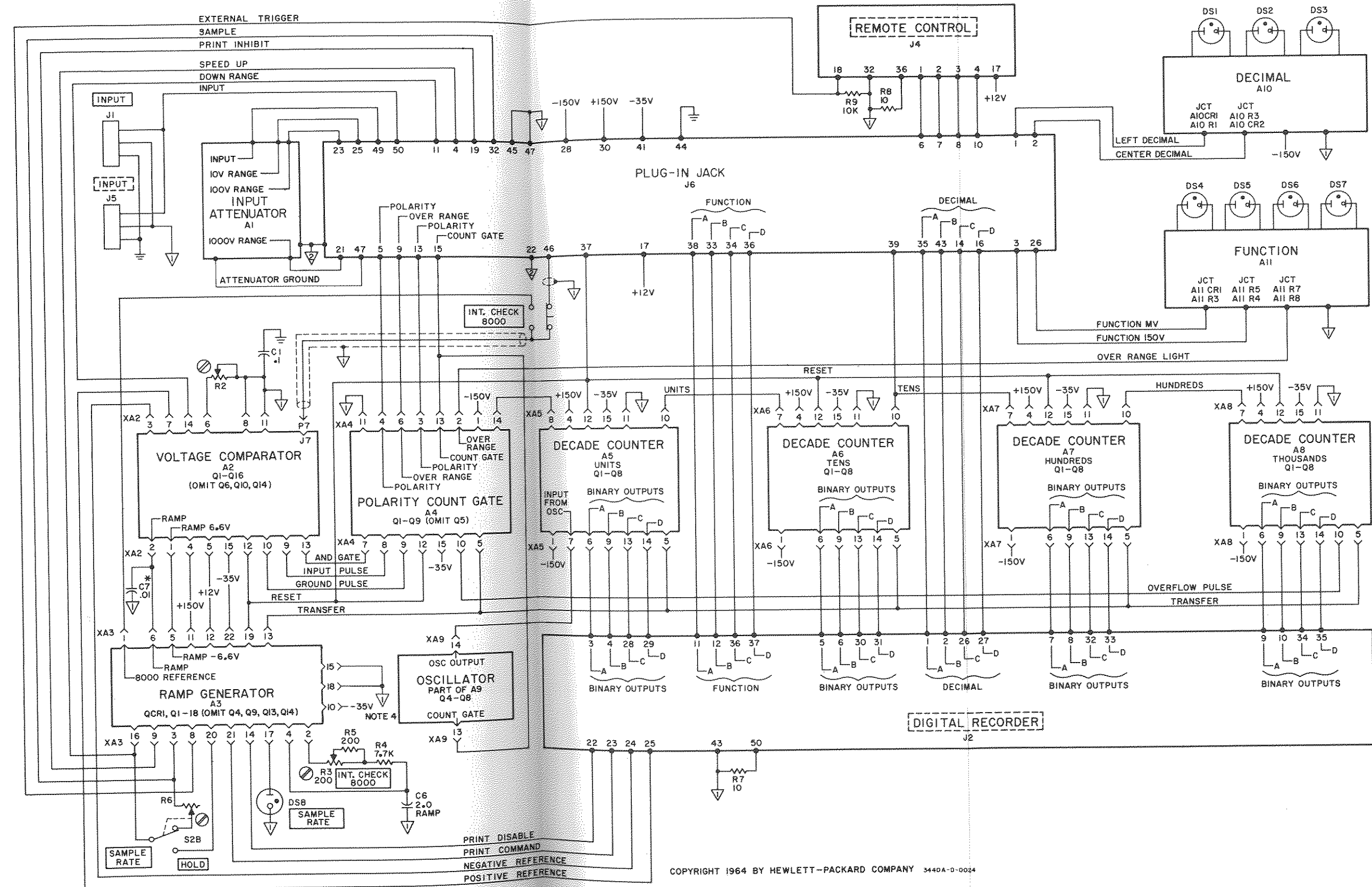


Figure 5-22. Wiring Diagram

NOTES

NOTES

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and Φ stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their Φ stock number and provides the following information on each part:

- a. Description of the part (see list of abbreviations below).
- b. Typical manufacturer of the part in a five-digit code (see list of manufacturers in Appendix).
- c. Manufacturer's part number.
- d. Total quantity used in the instrument (TQ column).

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see lists at rear of this manual for addresses. Identify parts by their Hewlett-Packard stock numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

- a. Instrument model number.
- b. Instrument serial number.
- c. Description of the part.
- d. Function and location of the part.

REFERENCE DESIGNATORS

A = assembly	F = fuse	P = plug	V = vacuum tube, neon bulb, photocell, etc.
B = motor	FL = filter	Q = transistor	W = cable
C = capacitor	J = jack	R = resistor	X = socket
CR = diode	K = relay	RT = thermistor	Y = crystal
DL = delay line	L = inductor	S = switch	Z = network
DS = device signaling (lamp)	M = meter	T = transformer	
E = misc electronic part	MP = mechanical part		

ABBREVIATIONS

A = amperes	ELECT = electrolytic	MTG = mounting	RMS = root-mean-square
AFC = automatic frequency control	ENCAP = encapsulated	MY = mylar	RMO = rack mount only
AMP = amplifier	F = farads	NC = normally closed	
BFO = beat frequency oscillator	FXD = fixed	NE = neon	S-B = slow-blow
BP = bandpass	GE = germanium	NO = normally open	SE = selenium
BWO = backward wave oscillator	GL = glass	NPO = negative positive zero (zero temperature coefficient)	SEMICON = semiconductor
CER = ceramic	GRD = ground(ed)	NSR = not separately replaceable	SECT = section(s)
CMO = cabinet mount only	H = henries	OBD = order by description	SI = silicon
COEF = coefficient	HG = mercury	OX = oxide	SIL = silver
COM = common	HR = hour(s)		SL = slide
COMP = composition	IMPG = impregnated	P = peak	SPL = special
CONN = connector	INCD = incandescent	PC = printed circuit board	TA = tantalum
CRT = cathode-ray tube	INS = insulation(ed)	PF = picofarads = 10^{-12} farads	TD = time delay
DEPC = deposited carbon	K = kilo = 1000	PP = peak-to-peak	TI = titanium
EIA = Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by Φ stock numbers.	LIN = linear taper	PIV = peak inverse voltage	TOG = toggle
	LOG = logarithmic taper	POR = porcelain	TOL = tolerance
	LPF = low pass filter	POS = position(s)	TRIM = trimmer
	MEG = meg = 10^6	POT = potentiometer	TWT = traveling wave tube
	M = milli = 10^{-3}	POLY = polystyrene	U = micro = 10^{-6}
	MINAT = miniature	POT = potentiometer	VAC = vacuum
	METFLM = metal film	RECT = rectifier	VAR = variable
	MFR = manufacturer	RF = radio frequency	W/ = with
	MOM = momentary	ROT = rotary	W = watts
			WW = wirewound
			W/O = without

Table 6-1. Index by Reference Designator

Circuit Reference	Stock No.	Description	Note
C1	0170-0022	C: fxd, my, 0.1 μ f, 20%, 600 vdcw	
C2	0180-0047	C: fxd, elect, 500 μ f, 75 vdcw	
C3	0180-0107	C: fxd, elect, 20 μ f, -10% +100%, 200 vdcw	
C4	0180-0107	C: fxd, elect, 20 μ f, -10% +100%, 200 vdcw	
C5		Not Assigned	
C6	0160-0221	C: fxd, poly, 2 μ f, 5%, 50 vdcw	
C7*	0160-0161	C: fxd, my, 0.01 μ f, 10%, 200 vdcw	
DS1 thru DS3	2140-0028	Lamp,Glow. Neon Frosted, NE2E	
DS4 thru DS7	2140-0015	Lamp,Glow, Neon, NE-2H	
DS8	1450-0049	Indicator: Lamp,Glow, Neon	
F1	2110-0016	Fuse: cartridge, 0.6 amp, slo-blo	
F2	2110-0033	Fuse: 0.75 amp, 250 v	
J1		Includes:	
	0340-0087	Insulator: Binding Post, 3 hole in-line	
	0340-0091	Insulator: Binding Post, 3 hole with pin	
	5060-0625	Binding Post Ass'y: Left Hand Link	
	5060-0634	Binding Post Ass'y: Red, 3/4" Stud	
	5060-0635	Binding Post Ass'y: Blk, 3/4" Stud	
J2	1251-0087	Connector: Female, 50 pin, miniature	
J3	1251-0148	Connector: Power	
J4	1251-0085	Connector: Female, 36 pin, miniature	
J5		Includes:	
	0340-0087	Insulator: Binding Post, 3 hole in-line	
	0340-0091	Insulator: Binding Post, 3 hole with pin	
	5060-0634	Binding Post Ass'y: Red, 3/4" Stud	
	5060-0635	Binding Post Ass'y: Blk, 3/4" Stud	
	5060-0635	Binding Post Ass'y: Blk, 3/4" Stud	
J6	1251-1026	Connector: Socket, female, 50 pin	
P7	1251-0324	Connector: Test Jack, male, red	
Q1	1850-0098	Transistor: Germanium, PNP, selected	
R1		Not Assigned	
R2	2100-0078	R: var, comp, 500 ohms, 30%, lin, 0.3 w	
R3	2100-0436	R: var, comp, 200 ohms, 20%, lin, 1/2 w	
R4*	0811-0143	R: fxd, ww, 7700 ohms, 0.5%, 1/4 w	
R5	0683-2015	R: fxd, comp, 200 ohms, 5%, 1/4 w	
R6	2100-0438	R: var, 250 K ohms, SPST, switch	
R7, R8	0684-1001	R: fxd, comp, 10 ohms, $\pm 10\%$, 1/4 w	
R9	0683-1035	R: fxd, comp, 10 K ohms $\pm 5\%$, 1/4 w	
S1		Not Assigned	
S2		N. S. R. Part of R6	
S3	3101-0053	Switch: Push-button, SPDT	
S4, S5		Not Assigned	
S6	3101-0033	Switch: Slide, 115/230 v	
T1	9100-0182	Transformer: Power	
W1	8120-0078	Cable: Power, SVT-18-3, 7.5 ft	

*Average value shown, optimum value selected at factory

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
XA2	1251-0135	Connector: 15 pin	
XA3	1251-0208	Connector: 22 pin	
XA4 thru XA9	1251-0135	Connector: 15 pin	
XF1, XF2	1400-0084	Fuseholder: Extractor, post type	
XQ1	1200-0044	Socket: Transistor	
A1	03440-67501	Ass'y: Attenuator Board	
A1C1	0160-0222	C: fxd, poly, 0.1 μ f, 20%, 1000 vdcw	
A1MP1 thru A1MP12	0340-0060	Insulator: Feed-thru	
A1R1	0811-0142	R: fxd, ww, 200 K ohms, 0.2%, 1/4 w	
A1R2 and A1R3	0811-0139	R: fxd, ww, 4.5 Megohms, 0.01%, 1/2 w	
A1R4	0811-0140	R: fxd, ww, 895 K ohms, 0.01%, 1/4 w	
A1R5	0811-0141	R: fxd, 99.55 K ohms, 0.01%, 1/4 w	
A1R6	0727-0255	R: fxd, depc, 800 K ohms, 1%, 1/2 w	
A1R7	2100-0451	R: var, ww, 10 K ohms, 10%, lin, 2 w	
A1R8	2100-0354	R: var, ww, 1000 ohms, 10%, lin, 2 w	
A2	03440-66503	Ass'y: Comparator Board	
A2C1 and A2C2	0160-0161	C: fxd, 0.01 μ f, 10%, 200 vdcw	
A2C3	0180-0039	C: fxd, elect, 100 μ f, 12 vdcw	
A2C4	0160-0162	C: fxd, 0.022 μ f, 10%	
A2C5 thru A2C7		Not Assigned	
A2C8	0160-0161	C: fxd, 0.01 μ f, 10%, 200 vdcw	
A2C9	0150-0121	C: fxd, cer, 0.1 μ f, 50 vdcw	
A2C10	0160-0178	C: fxd, mica, 27 pf, 5%, 300 vdcw	
A2C11 and A2C12		Not Assigned	
A2C13	0170-0070	C: fxd, my, 0.22 μ f, 20%, 50 vdcw	
A2C14	0180-0106	C: fxd, ta, 60 μ f, 20%, 6 vdcw	
A2C15	0140-0200	C: fxd, mica, 390 pf, 5%, 300 vdcw	
A2C16		Not Assigned	
A2C17	0140-0216	C: fxd, mica, 120 pf, 2%, 300 vdcw	
A2C18	0150-0121	C: fxd, cer, 0.1 μ f, 50 vdcw	
A2C19	0150-0098	C: fxd, cer, 0.01 μ f, 1000 vdcw	
A2C20 and A2C21		Not Assigned	
A2C22	0140-0194	C: fxd, mica, 110 pf, 5%, 300 vdcw	
A2C23	0140-0196	C: fxd, mica, 150 pf, 5%, 300 vdcw	
A2C24 and A2C25		Not Assigned	
A2C26	0170-0019	C: fxd, my, 0.1 μ f, 5%, 200 vdcw	
A2C27	0160-0161	C: fxd, 0.01 μ f, 10%, 200 vdcw	
A2C28	0150-0121	C: fxd, cer, 0.1 μ f, 50 vdcw	
A2C29 and A2C30		Not Assigned	

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A2C31	0170-0070	C: fxd, my, 0.22 μ f, 20%, 50 vdcw	
A2C32	0160-0178	C: fxd, mica, 27 pf, 5%, 300 vdcw	
A2C33	0180-0161	C: fxd, ta, 3.3 μ f, 20%, 35 vdcw	
A2C34	0140-0200	C: fxd, mica, 390 pf, 5%, 300 vdcw	
A2C35		Not Assigned	
A2C36	0140-0194	C: fxd, mica, 110 pf, 5%, 300 vdcw	
A2C37	0140-0196	C: fxd, mica, 150 pf, 5%, 300 vdcw	
A2CR1 and A2CR2	1901-0025	Semicon Device: diode, junction	
A2CR3 and A2CR4		Not Assigned	
A2CR5	1901-0052	Semicon Device: diode, pair, selected	
A2CR6 and A2CR7	1901-0053	Semicon Device: diode, junction	
A2CR8 and A2CR9		Not Assigned	
A2CR10	1901-0054	Semicon Device: diode, silicon	
A2CR11	1901-0033	Semicon Device: diode, 1N485B	
A2CR12	1901-0025	Semicon Device: diode, junction	
A2CR13 and A2CR14		Not Assigned	
A2CR15 and A2CR16	1901-0033	Semicon Device: diode, 1N485B	
A2CR17	1901-0025	Semicon Device: diode, junction	
A2CR18		Not Assigned	
A2CR19	1901-0033	Semicon Device: diode, 1N485B	
A2CR20	1901-0040	Semicon Device: diode, junction	
A2CR21		Not Assigned	
A2CR22 and A2CR23	1901-0025	Semicon Device: diode, junction	
A2CR24	1901-0033	Semicon Device: diode, 1N485B	
A2CR25 thru A2CR26		Not Assigned	
A2CR27	1901-0171	Semicon Device: diode, pair, selected	
A2CR28	1901-0033	Semicon Device: diode, 1N485B	
A2CR29	1901-0025	Semicon Device: diode, junction	
A2CR30 and A2CR31		Not Assigned	
A2CR32	1901-0033	Semicon Device: diode, 1N485B	
A2CR33 thru A2CR35		Not Assigned	
A2CR36	1901-0033	Semicon Device: diode, 1N485B	
A2J7	1251-0131	Connector: socket, female, 1 pin	
A2MP1 and A2MP2	0340-0060	Insulator: feed-thru	
A2Q1 and A2Q2	1850-0062	Transistor: Germanium, PNP, Selected	
A2Q3	1850-0096	Transistor: Germanium, 2N2189, PNP	
A2Q4 and A2Q5	1850-0062	Transistor: Germanium, PNP, Selected	

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A2Q6		Not Assigned	
A2Q7 and A2Q8	1850-0062	Transistor: Germanium, PNP, selected	
A2Q9	1850-0040	Transistor: Germanium, 2N383, PNP	
A2Q10		Not Assigned	
A2Q11 thru A2Q13	1850-0062	Transistor: Germanium, PNP, selected	
A2Q14		Not Assigned	
A2Q15 and 16	1850-0062	Transistor: Germanium, PNP, selected	
A2R1	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A2R2*	0757-0194	R: fxd, met flm, 1.33 megohms, 1%, 1/2 w	
A2R3 and A2R4		Not Assigned	
A2R5	0683-2035	R: fxd, comp, 20 K ohms, 5%, 1/4 w	
A2R6	0683-5125	R: fxd, comp, 5100 ohms, 5%, 1/4 w	
A2R7	0727-0168	R: fxd, depc, 15 K ohms, 1%, 1/2 w	
A2R8	0727-0222	R: fxd, depc, 214 K ohms, 1%, 1/2 w	
A2R9	0683-1545	R: fxd, comp, 150 K ohms, 5%, 1/4 w	
A2R10	0683-2035	R: fxd, comp, 20 K ohms, 5%, 1/4 w	
A2R11	0683-7525	R: fxd, comp, 7500 ohms, 5%, 1/4 w	
A2R12	0727-0206	R: fxd, depc, 98 K ohms, 1%, 1/2 w	
A2R13		Not Assigned	
A2R14	0683-2725	R: fxd, comp, 2700 ohms, 5%, 1/4 w	
A2R15		Not Assigned	
A2R16	0757-0196	R: fxd, met flm, 6.19 K ohms, 1%, 1/2 w	
A2R17	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A2R18	0683-7525	R: fxd, comp, 7500 ohms, 5%, 1/4 w	
A2R19	0683-4745	R: fxd, comp, 470 K ohms, 1/4 w	
A2R20 and A2R21		Not Assigned	
A2R22	0683-8235	R: fxd, comp, 82 K ohms, 5%, 1/4 w	
A2R23	0683-3335	R: fxd, comp, 33 K ohms, 5%, 1/4 w	
A2R24	0683-2015	R: fxd, comp, 200 ohms, 5%, 1/4 w	
A2R25	0683-2215	R: fxd, comp, 220 ohms, 5%, 1/4 w	
A2R26	0683-6825	R: fxd, comp, 6800 ohms, 5%, 1/4 w	
A2R27		Not Assigned	
A2R28	0687-5661	R: fxd, comp, 56 megohms, 10%, 1/2 w	
A2R29*	0683-2035	R: fxd, comp, 20 K ohms, 5%, 1/4 w	
A2R30	0683-2445	R: fxd, comp, 240 K ohms, 5%, 1/4 w	
A2R31	0683-1025	R: fxd, comp, 1000 ohms, 5%, 1/4 w	
A2R32	0683-3335	R: fxd, comp, 33 K ohms, 5%, 1/4 w	
A2R33		Not Assigned	
A2R34	0757-0192	R: fxd, met flm, 60.4 K ohms, 1%, 1/2 w	
A2R35	0683-3935	R: fxd, comp, 39 K ohms, 1/4 w	
A2R36	0757-0198	R: fxd, met flm, 100 ohms, 1%, 1/2 w	
A2R37		Not Assigned	
A2R38	0727-0122	R: fxd, depc, 2.51 K ohms, 1%, 1/2 w	
A2R39	0683-5615	R: fxd, 560 ohms, 5%, 1/4 w	
A2R40	2100-0439	R: var, ww, 250 ohms, lin, 20%, 1/4 w	
A2R41	0698-3123	R: fxd, depc, 3830 ohms, 1%, 1/2 w	
A2R42		Not Assigned	
A2R43	0757-0191	R: fxd, met flm, 80.6 K ohms, 1%, 1/2 w	

* Average value shown, optimum value selected at factory

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A2R44	0757-0190	R: fxd, met flm, 20 K ohms, 1%, 1/2 w	
A2R45	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A2R46	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A2R47	0683-5635	R: fxd, comp, 56 K ohms, 5%, 1/4 w	
A2R48	0683-6825	R: fxd, comp, 6800 ohms, 5%, 1/4 w	
A2R49 and A2R50		Not Assigned	
A2R51	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A2R52	0683-3345	R: fxd, comp, 330 K ohms, 5%, 1/4 w	
A2R53	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A2R54	0683-5645	R: fxd, comp, 560 K ohms, 5%, 1/4 w	
A2R55	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A2R56 and A2R57		Not Assigned	
A2R58	0683-6825	R: fxd, comp, 6800 ohms, 5%, 1/4 w	
A2R59	0683-2235	R: fxd, comp, 22 K ohms, 5%, 1/4 w	
A2R60	0683-5635	R: fxd, comp, 56 K ohms, 5%, 1/4 w	
A2R61	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A2R62	0683-2745	R: fxd, comp, 270 K ohms, 5%, 1/4 w	
A2R63	0683-2235	R: fxd, comp, 22 K ohms, 5%, 1/4 w	
A2R64	0683-1225	R: fxd, comp, 1200 ohms, 5%, 1/4 w	
A2R65	0683-3625	R: fxd, comp, 3600 ohms, 5%, 1/4 w	
A2R66	0683-3615	R: fxd, comp, 360 ohms, 5%, 1/4 w	
A2R67		Not Assigned	
A2R68	0727-0168	R: fxd, carbon flm, 15 K ohms, 1%, 1/2 w	
A2R69	0727-0124	R: fxd, carbon flm, 3000 ohms, 1%, 1/2 w	
A2R70	2100-0239	R: var, ww, 2000 ohms, 20%, lin, 1-1/4 w	
A2R71	0757-0195	R: fxd, met flm, 348 K ohms, 1%, 1/2 w	
A2R72	0683-3935	R: fxd, comp, 39 K ohms, 1/4 w	
A2R73		Not Assigned	
A2R74	0757-0190	R: fxd, met flm, 20 K ohms, 1%, 1/2 w	
A2R75	0683-8235	R: fxd, comp, 82 K ohms, 5%, 1/4 w	
A2R76	0683-3335	R: fxd, comp, 33 K ohms, 5%, 1/4 w	
A2R77	0683-2015	R: fxd, comp, 200 ohms, 5%, 1/4 w	
A2R78	0683-2215	R: fxd, comp, 220 ohms, 5%, 1/4 w	
A2R79	0683-6825	R: fxd, comp, 6800 ohms, 5%, 1/4 w	
A2R80		Not Assigned	
A2R81	0757-0192	R: fxd, met flm, 60.4 K ohms, 1%, 1/2 w	
A2R82	0683-3935	R: fxd, comp, 39 K ohms, 1/4 w	
A2R83	0757-0197	R: fxd, met flm, 1500 ohms, 1%, 1/2 w	
A2R84	0757-0191	R: fxd, met flm, 80.6 K ohms, 1%, 1/2 w	
A2R85	0757-0190	R: fxd, met flm, 20 K ohms, 1%, 1/2 w	
A2R86		Not Assigned	
A2R87	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A2R88	0683-6825	R: fxd, comp, 6800 ohms, 5%, 1/4 w	
A2R89	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A2R90	0683-5635	R: fxd, comp, 56 K ohms, 5%, 1/4 w	
A2R91		Not Assigned	
A2R92 and A2R93	0683-2245	R: fxd, 220 K, 5%, 1/4 w	
A2R94	0683-6825	R: fxd, comp, 6800 ohms, 5%, 1/4 w	
A2R95	0683-2235	R: fxd, comp, 22 K ohms, 5%, 1/4 w	
A2R96	0683-5635	R: fxd, comp, 56 K ohms, 5%, 1/4 w	

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A2R97	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A2R98	0683-2745	R: fxd, comp, 270 K ohms, 5%, 1/4 w	
A2TP1 thru A2TP4	0360-0124	Terminal	
A3	03440-66507	Ass'y: Display and Ramp Board	
A3C1	0150-0012	C: fxd, cer, 0.01 μ f, 20%, 1000 vdcw	
A3C2	0180-0049	C: fxd, elect, 20 μ f, 50 vdcw	
A3C3	0150-0050	C: fxd, cer, 1000 pf, 600 vdcw	
A3C4		Not Assigned	
A3C5	0180-0105	C: fxd, elect, 50 μ f, 25 vdcw	
A3C6 thru A3C9		Not Assigned	
A3C10	0170-0019	C: fxd, my, 0.1 μ f, 5%, 200 vdcw	
A3C11	0160-0153	C: fxd, 0.001 μ f, 10%	
A3CR1	1901-0025	Semicon Device: diode, junction	
A3CR2 thru A3CR4		Not Assigned	
A3CR5 thru A3CR9	1901-0025	Semicon Device: diode, junction	
A3CR10		Not Assigned	
A3CR11	1901-0033	Semicon Device: diode, 1N485B	
A3CR12 and A3CR13		Not Assigned	
A3CR14	1902-0071	Semicon Device: diode, silicon breakdown	
A3CR15 and A3CR16	1901-0025	Semicon Device: diode, junction	
A3Q1	1854-0022	Transistor: NPN, silicon, selected	
A3Q2	1850-0040	Transistor: Germanium, 2N383, PNP	
A3Q3	1851-0024	Transistor: Germanium, 2N388A, NPN	
A3Q4		Not Assigned	
A3Q5 thru A3Q7	1850-0062	Transistor: Germanium, selected, PNP	
A3Q8	1851-0017	Transistor: 2N1304	
A3Q9		Not Assigned	
A3Q10	1851-0017	Transistor: 2N1304	
A3Q11	1850-0062	Transistor: Germanium, PNP, selected	
A3Q12	1850-0040	Transistor: Germanium, 2N383, PNP	
A3Q13 and A3Q14		Not Assigned	
A3Q15	1853-0001	Transistor: PNP, silicon, selected	
A3Q16	1854-0003	Transistor: NPN, silicon, selected	
A3Q17	1854-0022	Transistor: NPN, silicon, selected	
A3Q18	1854-0029	Transistor: 2N2712, silicon	
A3QCR1	1820-0001	Semicon Device: Transistor--diode, silicon	
A3R1	0683-2245	R: fxd, comp, 220 K ohms, 5%, 1/4 w	
A3R2	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A3R3	0683-6235	R: fxd, comp, 62 K ohms, 5%, 1/4 w	
A3R4 and A3R5		Not Assigned	

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A3R6	0683-5615	R: fxd, comp, 560 ohms, 5%, 1/4 w	
A3R7 and A3R8	0683-2225	R: fxd, 2.2 K ohms, 5%, 1/4 w	
A3R9	0683-6825	R: fxd, comp, 6800 ohms, 5%, 1/4 w	
A3R10		Not Assigned	
A3R11	0683-1225	R: fxd, comp, 1200 ohms, 5%, 1/4 w	
A3R12	0683-1025	R: fxd, comp, 1000 ohms, 5%, 1/4 w	
A3R13	0683-6835	R: fxd, comp, 68 K ohms, 5%, 1/4 w	
A3R14	0683-4725	R: fxd, comp, 4700 ohms, 5%	
A3R15 thru A3R17		Not Assigned	
A3R18*	0686-4725	R: fxd, comp, 4700 ohms, 5%, 1/2 w	
A3R19*	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A3R20	1083-2735	R: fxd, comp, 27 K ohms, 5%, 1/4 w	
A3R21	0683-2725	R: fxd, comp, 2700 ohms, 5%, 1/4 w	
A3R22 and A3R23		Not Assigned	
A3R24	0683-1025	R: fxd, comp, 1000 ohms, 5%, 1/4 w	
A3R25 and A3R26	0683-1835	R: fxd, comp, 18 K ohms, 5%, 1/4 w	
A3R27	0683-1535	R: fxd, comp, 15 K ohms, 5%, 1/4 w	
A3R28	0683-5135	R: fxd, comp, 51 K ohms, 5%, 1/4 w	
A3R29 and A3R30	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A3R31	0683-5135	R: fxd, comp, 51 K ohms, 5%, 1/4 w	
A3R32	0683-4745	R: fxd, comp, 470 K ohms, 5%, 1/4 w	
A3R33		Not Assigned	
A3R34	0683-1535	R: fxd, comp, 15 K ohms, 5%, 1/4 w	
A3R35	0683-3935	R: fxd, comp, 39 K ohms, 1/4 w	
A3R36 and A3R37	0689-1835	R: fxd, comp, 18 K ohms, 5%, 1 w	
A3R38 and A3R39		Not Assigned	
A3R40 and A3R41	0683-3335	R: fxd, comp, 33 K ohms, 5%, 1/4 w	
A3R42	0683-1835	R: fxd, comp, 18 K ohms, 5%, 1/4 w	
A3R43 and A3R44		Not Assigned	
A3R45 and A3R46	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A3R47	0683-1535	R: fxd, comp, 15 K ohms, 5%, 1/4 w	
A3R48	0683-2225	R: fxd, comp, 2.2 K ohms, 5%, 1/4 w	
A3R49 and A3R50		Not Assigned	
A3R51	2100-0392	R: var, 2 K ohms, lin, 10%, 1/4 w	
A3R52	0683-5625	R: fxd, comp, 5600 ohms, 5%, 1/4 w	
A3R53	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A3R54	0683-3025	R: fxd, comp, 3000 ohms, 5%, 1/4 w	
A3R55 and A3R56		Not Assigned	
A3R57	0757-0193	R: fxd, met flm, 3.32 K ohms, 1%, 1/2 w	
A3R58	0811-0145	R: fxd, ww, 2150 ohms, 0.2%, 1/4 w	

*Average value shown, optimum value selected at factory

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A3R59	03440-82601	R: fxd, ww, 370, 740 and 1480 ohms	
A3R60	2100-0324	R: var, ww, 500 ohms, lin, 10%, 1/4 w	
A3R61	0811-0144	R: fxd, 25 K ohms, 0.2%, 1/4 w	
A3R62	0683-1035	R: fxd, comp, 10 K ohms, $\pm 5\%$, 1/4 w	
A3R63	0683-1545	R: fxd, comp, 150 K ohms, $\pm 5\%$, 1/4 w	
A3R64	0683-2235	R: fxd, comp, 22 K ohms, $\pm 5\%$, 1/4 w	
A3R65	0683-1235	R: fxd, comp, 12 K ohms, $\pm 5\%$, 1/4 w	
A4	03440-66504	Ass'y: Polarity Board	
A4C1	0140-0194	C: fxd, mica, 110 pf, 5%, 300 vdcw	
A4C2	0140-0198	C: fxd, mica, 200 pf, 5%, 300 vdcw	
A4C3	0150-0096	C: fxd, cer, 0.05 μ f, 100 vdcw	
A4C4 thru A4C5		Not Assigned	
A4C6 and A4C7	0140-0175	C: fxd, mica, 39 pf, 2%, 300 vdcw	
A4C8 and A4C9		Not Assigned	
A4C10	0140-0225	C: fxd, mica, 300 pf, 1%, 300 vdcw	
A4C11		Not Assigned	
A4C12	0140-0194	C: fxd, mica, 110 pf, 5%, 300 vdcw	
A4CR5 and A4CR6	1901-0025	Semicon Device: diode, junction	
A4CR7		Not Assigned	
A4CR8 and A4CR9	1901-0025	Semicon Device: diode, junction	
A4CR10	1910-0015	Semicon Device: diode, germanium	
A4CR11 thru A4CR17		Not Assigned	
A4CR18	1901-0025	Semicon Device: diode, junction	
A4DS1	1970-0012	Digit Display Tube: Neon, ($\pm$)	
A4DS2 Ass'y	03440-69501	Exciter: Photoconductor, Polarity Includes: DS2, block, MP1 and MP2	
A4MP1	0905-0043	Gasket: Photoconductor, included in A4DS4	
A4MP2	0905-0051	Light Mask: Felt, included in A4DS4	
A4MP3	5212A-83C	Cover: Photoconductor	
A4Q1 thru A4Q3	1850-0062	Transistor: Germanium, PNP, selected	
A4Q4	1851-0017	Transistor: 2N1304	
A4Q5		Not Assigned	
A4Q6 thru A4Q9	1850-0062	Transistor: Germanium, PNP, selected	
A4R1	0683-5635	R: fxd, comp, 56 K ohms, 5%, 1/4 w	
A4R2	0683-4725	R: fxd, comp, 4700 ohms, 5%	
A4R3	0683-1535	R: fxd, comp, 15 K ohms, 5%, 1/4 w	
A4R4	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A4R5	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A4R6	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A4R7	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A4R8		Not Assigned	
A4R9	0683-2235	R: fxd, comp, 22 K ohms, 5%, 1/4 w	

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A4R10 and A4R11	0683-4725	R: fxd, comp, 4700 ohms, 5%, 1/4 w	
A4R12		Not Assigned	
A4R13	0686-2725	R: fxd, comp, 2700 ohms, 5%, 1/2 w	
A4R14	0683-2705	R: fxd, comp, 27 ohms, 5%, 1/4 w	
A4R15	0683-2235	R: fxd, comp, 22 K ohms, 5%, 1/4 w	
A4R16	0683-4725	R: fxd, comp, 4700 ohms, 5%	
A4R17 and A4R18		Not Assigned	
A4R19	0687-6831	R: fxd, 68 K ohms, 10%, 1/2 w	
A4R20 and A4R21	0683-2745	R: fxd, comp, 270 K ohms, 5%, 1/4 w	
A4R22		Not Assigned	
A4R23	0683-3945	R: fxd, comp, 390 K ohms, 5%, 1/4 w	
A4R24 and A4R25	0683-5635	R: fxd, comp, 56 K ohms, 5%, 1/4 w	
A4R26 and A4R27		Not Assigned	
A4R28	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A4R29	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A4R30		Not Assigned	
A4R31	0683-4725	R: fxd, comp, 4700 ohms, 5%	
A4R32 and A4R33		Not Assigned	
A4R34 and A4R35	0683-7525	R: fxd, comp, 7500 ohms, 5%, 1/4 w	
A4R36	0683-1815	R: fxd, comp, 180 ohms, 5%, 1/4 w	
A4R37 and A4R38		Not Assigned	
A4R39	0683-4725	R: fxd, comp, 4700 ohms, 5%, 1/4 w	
A4R40	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A4R41	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A4R42 and A4R43		Not Assigned	
A4R44	0683-5635	R: fxd, comp, 56 K ohms, 5%, 1/4 w	
A4R45	0683-3945	R: fxd, comp, 390 K ohms, 5%, 1/4 w	
A4R46	0683-5635	R: fxd, comp, 56 K ohms, 5%, 1/4 w	
A4R47	0683-2745	R: fxd, comp, 270 K ohms, 5%, 1/4 w	
A4R48	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A4R49		Not Assigned	
A4R50	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A4R51	0683-1535	R: fxd, comp, 15 K ohms, 5%, 1/4 w	
A4R52	0683-2235	R: fxd, comp, 22 K ohms, 5%, 1/4 w	
A4R53	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A4R54	0683-4725	R: fxd, comp, 4700 ohms, 5%, 1/4 w	
A4R55 and A4R56		Not Assigned	
A4R57 and A4R58	0683-7525	R: fxd, comp, 7500 ohms, 5%, 1/4 w	
A4R59	0683-1815	R: fxd, comp, 180 ohms, 5%, 1/4 w	
A4R60		Not Assigned	
A4R61	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A4R62	0683-4725	R: fxd, comp, 4700 ohms, 5%	

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Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A4V1	1990-0010	Plate: Photoconductor Matrix	
A4XDS1	5212L-83C	Socket: Digit Display Tube	
A4A1	03440-69502	Photoconductor Assembly: Polarity Includes: DS2, V1, XDS1 and MP3	
A5	5212L-4A	Counter Ass'y: Decade	
A5C1	0140-0194	C: fxd, mica, 110 pf, 5%, 300 vdcw	
A5C2	0140-0217	C: fxd, mica, 140 pf, 2 %, 300 vdcw	
A5C3	0140-0194	C: fxd, mica, 110 pf, 5%, 300 vdcw	
A5C4	0140-0195	C: fxd, mica, 130 pf, 5%, 300 vdcw	
A5C5	0140-0194	C: fxd, mica, 110 pf, 5%, 300 vdcw	
A5C6	0140-0194	C: fxd, mica, 110 pf, 5%, 300 vdcw	
A5C7	0140-0198	C: fxd, mica, 200 pf, 5%, 300 vdcw	
A5C8 and A5C9	0140-0194	C: fxd, mica, 110 pf, 5%, 300 vdcw	
A5C10	0140-0195	C: fxd, mica, 130 pf, 5%, 300 vdcw	
A5C11 and A5C12	0140-0198	C: fxd, mica, 200 pf, 5%, 300 vdcw	
A5C13	0140-0199	C: fxd, mica, 240 pf, 5%, 300 vdcw	
A5CR1 thru A5CR8	1901-0025	Semicon Device: diode, junction	
A5CR9 thru A5CR13	1910-0015	Semicon Device: diode, germanium	
A5DS1	05212-6010	Exciter: Photoconductor Matrix	
A5DS2 thru A5DS5		Not Assigned	
A5DS6	1970-0009	Digit Display Tube: Neon, 10 digit	
A5MP1	0905-0043	Gasket: Photoconductor	
A5MP2	0905-0051	Light Mask: Felt, included in A5DS1	
A5MP3	5212A-83C	Cover: Photoconductor, included in A5DS1	
A5Q1 thru A5Q8	1850-0062	Transistor: Germanium, PNP, selected	
A5R1	0686-4735	R: fxd, comp, 47 K ohms, 5%, 1/2 w	
A5R2	0845-0001	Network: Resistive	
A5R3 thru A5R5		Not Assigned	
A5R6 thru A5R9	0683-3945	R: fxd, comp, 390 K ohms, 5%, 1/4 w	
A5R10 thru A5R17	0683-5635	R: fxd, comp, 56 K ohms, 5%, 1/4 w	
A5R18	0686-7525	R: fxd, comp, 7500 ohms, 5%, 1/2 w	
A5R19	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A5R20	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A5R21	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A5R22	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A5R23	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/2 w	
A5R24	0683-1815	R: fxd, comp, 180 ohms, 5%, 1/4 w	
A5R25	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A5R26	0686-7525	R: fxd, comp, 7500 ohms, 5%, 1/2 w	
A5R27	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	

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Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A5R28	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A5R29	0686-7525	R: fxd, comp, 7500 ohms, 5%, 1/2 w	
A4R30	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A5R31	0683-8225	R: fxd, comp, 8200 ohms, 5%, 1/4 w	
A5R32	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A5R33	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A5R34	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A5R35	0683-1815	R: fxd, comp, 180 ohms, 5%, 1/4 w	
A5R36	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A5R37	0686-7525	R: fxd, comp, 7500 ohms, 5%, 1/2 w	
A5R38	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A5R39	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A5R40	0686-7525	R: fxd, comp, 7500 ohms, 5%, 1/2 w	
A5R41	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A5R42	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A5R43	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A5R44	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A5R45	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A5R46	0683-1815	R: fxd, comp, 180 ohms, 5%, 1/4 w	
A5R47	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A5R48	0686-7525	R: fxd, comp, 7500 ohms, 5%, 1/2 w	
A5R49	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A5R50	0683-8225	R: fxd, comp, 8200 ohms, 5%, 1/4 w	
A5R51	0683-6835	R: fxd, comp, 68 K ohms, 5%, 1/4 w	
A5R52	0686-7525	R: fxd, comp, 7500 ohms, 5%, 1/2 w	
A5R53	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A5R54	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A5R55	0683-1045	R: fxd, comp, 100 K ohms, 5%, 1/4 w	
A5R56	0683-4735	R: fxd, comp, 47 K ohms, 5%, 1/4 w	
A5R57	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A5R58	0683-1815	R: fxd, comp, 180 ohms, 5%, 1/4 w	
A5R59	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A5R60	0686-7525	R: fxd, comp, 7500 ohms, 5%, 1/2 w	
A5R61	0683-4335	R: fxd, comp, 43 K ohms, 5%, 1/4 w	
A5R62	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A5V1	1990-0010	Plate: Photoconductor Matrix	
A5XDS6	5212L-83C	Socket: Digit Display Tube	
A5A1	05212-6011	Indicator Ass'y: Digit Includes: DS1, R2, V1, MP1, MP2, MP3	
A6		Same as A5	
A7		Same as A5	
A8		Same as A5	

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A9	03440-66501	Board Ass'y: Power Supply and Oscillator	
A9C1	0170-0024	C: fxd, my, 0.022 μ f, 20%, 200 vdcw	
A9C2 and A9C3	0180-0050	C: fxd, elect, 40 μ f, -15% +100%, 50 vdcw	
A9C4 and A9C5		Not Assigned	
A9C6	0180-0091	C: fxd, elect, 10 μ f, 1000 vdcw	
A9C7	0180-0050	C: fxd, elect, 40 μ f, -15% +100%, 50 vdcw	
A9C8	0180-0061	C: fxd, elect, 100 μ f, +100% -10%, 15 vdcw	
A9C9 thru A9C12		Not Assigned	
A9C13	0160-0223	C: fxd, mica, 33 pf, 5%, 500 vdcw	
A9C14	0130-0001	C: var, 7-45 pf, 500 vdcw	
A9C15*	0160-0191	C: fxd, mica, 272.2 pf, 1%, 300 vdcw	
A9C16	0140-0172	C: fxd, mica, 0.003 μ f, 1%, 100 vdcw	
A9C17 and A9C18		Not Assigned	
A9C19	0170-0055	C: fxd, my, 0.1 μ f, 20%, 200 vdcw	
A9C20	0150-0050	C: fxd, cer, 1000 pf, 600 vdcw	
A9C21	0140-0208	C: fxd, mica, 680 pf, 5%, 300 vdcw	
A9C22	0150-0121	C: fxd, cer, 0.1 μ f, 50 vdcw	
A9CR1 thru A9CR4	1901-0026	Semicon Device: diode, junction, 1N3253	
A9CR5		Not Assigned	
A9CR6 thru A9CR9	1901-0029	Diode: silicon, piv 600 v, 1 avg 0.75A, 1N3255	
A9CR10		Not Assigned	
A9CR11	1902-0048	Semicon Device: diode, breakdown	
A9CR12	1902-0031	Semicon Device: diode, avalanche	
A9CR13 and A9CR14		Not Assigned	
A9CR15	1910-0016	Semicon Device: diode, germanium	
A9L1	9140-0118	Coil: fxd, 500 μ h, 5%	
A9Q1 and A9Q2	1850-0062	Transistor: germanium, PNP, selected	
A9Q3		Not Assigned	
A9Q4	1850-0062	Transistor: germanium, PNP, selected	
A9Q5	1851-0017	Transistor: 2N1304	
A9Q6	1850-0062	Transistor: germanium, PNP, selected	
A9Q7	1853-0009	Transistor: germanium	
A9Q8	1850-0103	Transistor: germanium, 2N2190	
A9R1	0761-0026	R: fxd, met ox flm, 220 ohms, 5%, 1 w	
A9R2	0758-0024	R: fxd, met flm, 100 ohms, 5%, 1/2 w	
A9R3	0687-5621	R: fxd, comp, 5600 ohms, 10%, 1/2 w	
A9R4 and A9R5		Not Assigned	
A9R6	0683-1235	R: fxd, comp, 12 K ohms, 5%, 1/4 w	
A9R7	0683-1025	R: fxd, comp, 1000 ohms, 5%, 1/4 w	
A9R8	0683-2745	R: fxd, comp, 270 K ohms, 5%, 1/4 w	
A9R9		Not Assigned	
A9R10	0758-0004	R: fxd, met flm, 2700 ohms, 5%, 1/2 w	

*Average value shown, optimum value selected at factory

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
A9R11	0758-0002	R: fxd, met flm, 560 ohms, 5%, 1/2 w	
A9R12	2100-0238	R: var, ww, 250 ohms, 20%, lin, 1-1/4 w	
A9R13	0813-0019	R: fxd, ww, 0.47 ohms, 10%, 1/2 w	
A9R14		Not Assigned	
A9R15 and A9R16	0687-1221	R: fxd, comp, 1200 ohms, 10%, 1/2 w	
A9R17		Not Assigned	
A9R18	0683-1245	R: fxd, comp, 120 K ohms, 5%, 1/4 w	
A9R19 and A9R20	0683-1015	R: fxd, comp, 100 ohms, 5%, 1/4 w	
A9R21 thru A9R23		Not Assigned	
A9R24	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A9R25	0683-6835	R: fxd, comp, 68 K ohms, 5%, 1/4 w	
A9R26 thru A9R27		Not Assigned	
A9R28	0683-1245	R: fxd, comp, 120 K ohms, 5%, 1/4 w	
A9R29	0683-2215	R: fxd, comp, 220 ohms, 5%, 1/4 w	
A9R30	0683-1235	R: fxd, comp, 12 K ohms, 5%, 1/4 w	
A9R31	0683-4725	R: fxd, comp, 4700 ohms, 5%	
A9R32		Not Assigned	
A9R33 and A9R34	0683-1035	R: fxd, comp, 10 K ohms, 5%, 1/4 w	
A9R35	0683-1235	R: fxd, comp, 12 K ohms, 5%, 1/4 w	
A9R36	0683-5625	R: fxd, comp, 5600 ohms, 5%, 1/4 w	
A9R37		Not Assigned	
A9R38 and A9R39	0683-5625	R: fxd, comp, 5600 ohms, 5%, 1/4 w	
A9R40	0683-2225	R: fxd, 2.2 K ohms, 5%, 1/4 w	
A9R41	0683-4705	R: fxd, comp, 47 ohms, 5%, 1/4 w	
A9R42	0683-3925	R: fxd, comp, 3900 ohms, 5%, 1/4 w	
A9TP1	0360-0124	Terminal	
A10	03440-66505	Ass'y: Decimal Board	
A10CR1 and A10CR2	1901-0025	Semicon Device: diode, junction	
A10R1	0683-6835	R: fxd, comp, 68 K ohms, 5%, 1/4 w	
A10R2	0683-1055	R: fxd, comp, 1 megohm, 5%, 1/4 w	
A10R3	0683-6835	R: fxd, comp, 68 K ohms, 5%, 1/4 w	
A10R4	0683-1055	R: fxd, comp, 1 megohm, 5%, 1/4 w	
A10R5	0683-6835	R: fxd, comp, 68 K ohms, 5%, 1/4 w	
A10R6	0683-1055	R: fxd, comp, 1 megohm, 5%, 1/4 w	
A11	03440-66506	Ass'y: Function Board	
A11CR1	1901-0025	Semicon Device: diode, junction	
A11R1 and A11R2		Not Assigned	
A11R3	0683-6835	R: fxd, comp, 68 K ohms, 5%, 1/4 w	
A11R4	0683-1055	R: fxd, comp, 1 megohm, 5%, 1/4 w	
A11R5	0683-6835	R: fxd, comp, 68 K ohms, 5%, 1/4 w	
A11R6	0683-1055	R: fxd, comp, 1 megohm, 5%, 1/4 w	
A11R7 and A11R8	0683-6835	R: fxd, comp, 68 K ohms, 5%, 1/4 w	

See introduction to this section

Table 6-1. Index by Reference Designator (cont'd)

Circuit Reference	Stock No.	Description	Note
		<u>MISCELLANEOUS</u>	
	0370-0133	Knob: Round, blk, 5/8", w/arrow	
	0390-0006	Spacer: Nylon	
	1000-0017	Window: Polaroid	
	1200-0081	Insulator: Bushing	
	1200-0091	Insulator: Transistor, 800 v	
	1410-0094	Bushing: Panel	
	1490-0030	Stand: Tilt	
	5000-0732	Rear Side Cover: 5 x 11 fm	
	5000-0733	Front Side Cover: 5 x 11 fm	
	5060-0739	Cover Ass'y: Top, 11L fm	
	5060-0751	Cover Ass'y: Bottom, 11L fm	
	5060-0763	Handle Ass'y: Side	
	5060-0766	Retainer: Handle Ass'y	
	5060-0767	Foot Ass'y: fm	
	9211-0248	Carton: Shipping	
	9223-0040	Foam: Polyethylene, "Post Pak"	
	03440-00201	Panel: Front	
	03440-00202	Panel: Rear	
	03440-01201	Bracket: P. C. Board	
	03440-01202	Bar: Readout	
	03440-01203	Bracket: DCV	
	03440-01204	Bar: Support	
	03440-01205	Bracket: Connector	
	03440-24701	Support: Readout	
	03440-24702	Bar: Retainer	
	03440-48301	Guide: Plug-in	
	03440-48302	Insert: Units readout	
	03440-48303	Bezel: Window	
	03440-48304	Readout: Units	
	03440-48305	Support: Readout	
	03440-84401	Kit: Accessory	
	03440-90001	Operating and Service Manual	
	5212L-83D	Holder: Decimal	

See introduction to this section

Table 6-2. Replaceable Parts

Stock No.	Description	Mfr.	Mfr. Part No.	TQ
0180-0049	C: fxd, elect, 200 μ f, 50 vdcw	56289	30D198A1	1
0180-0050	C: fxd, elect, 40 μ f -15% +100%, 50 vdcw	56289	D32538	3
0180-0061	C: fxd, elect, 100 μ f +100% -10%, 15 vdcw	56289	30D172A1	1
0180-0105	C: fxd, elect, 50 μ f, 25 vdcw	56289	S97441	1
0180-0106	C: fxd, elect, 60 μ f, 20%, 6 vdcw	56289	150D606X000 6B2	1
0180-0107	C: fxd, elect, 20 μ f -10% +100%, 200 vdcw	56289	90803	2
0180-0161	C: fxd, ta, 3.3 μ f, 20%, 35 vdcw	56289	150D335X003 5B2	1
0340-0060	Insulator: Feed-thru	28480	0340-0060	14
0340-0087	Insulator: Bind post, 3 hole, in-line	28480	0340-0087	2
0340-0091	Insulator: Bind post, 3 hole with pin	28480	0340-0091	2
0360-0124	Terminal	28480	0360-0124	5
0370-0133	Knob, 5/8", blk, w/arrow	28480	0370-0133	1
0390-0006	Spacer: nylon	28480	0390-0006	4
0683-1001	R: fxd, comp, 10 ohms 5%, 1/4 w	01121	CB 1001	2
0683-1015	R: fxd, comp, 100 ohms 5%, 1/4 w	01121	CB 1015	2
0683-1025	R: fxd, comp, 1000 ohms 5%, 1/4 w	01121	CB 1025	4
0683-1035	R: fxd, comp, 10 K ohms 5%, 1/4 w	01121	CB 1035	32
0683-1045	R: fxd, comp, 100 K ohms 5%, 1/4 w	01121	CB 1045	27
0683-1055	R: fxd, comp, 1 megohm 5%, 1/4 w	01121	CB 1055	5
0683-1225	R: fxd, comp, 1200 ohms 5%, 1/4 w	01121	CB 1225	2
0683-1235	R: fxd, comp, 12 K ohms 5%, 1/4 w	01121	CB 1235	4
0683-1245	R: fxd, comp, 120 K ohms 5%, 1/4 w	01121	CB 1245	2
0683-1535	R: fxd, comp, 15 K ohms 5%, 1/4 w	01121	CB 1535	5
0683-1545	R: fxd, comp, 150 K ohms 5%, 1/4 w	01121	CB 1545	2
0683-1815	R: fxd, comp, 180 ohms 5%, 1/4 w	01121	CB 1815	18
1683-1835	R: fxd, comp, 18 K ohms 5%, 1/4 w	01121	CB 1835	3
0683-2015	R: fxd, comp, 200 ohms 5%, 1/4 w	01121	CB 2015	3
0683-2035	R: fxd, comp, 20 K ohms 5%, 1/4 w	01121	CB 2035	3
0683-2215	R: fxd, comp, 220 ohms 5%, 1/4 w	01121	CB 2215	3
0683-2225	R: fxd, 2.2 K ohms 5%, 1/4 w	01121	CB 2225	4
0683-2235	R: fxd, comp, 22 K ohms 5%, 1/4 w	01121	CB 2235	7
0683-2245	R: fxd, 220 K ohms 5%, 1/4 w	01121	CB 2245	3
0683-2445	R: fxd, comp, 240 K ohms 5%, 1/4 w	01121	CB 2445	1
0683-2705	R: fxd, comp, 27 ohms 5%, 1/4 w	01121	CB 2705	1
0683-2725	R: fxd, comp, 2700 ohms 5%, 1/4 w	01121	CB 2725	2
0683-2735	R: fxd, comp, 27 K ohms 5%, 1/4 w	01121	CB 2735	1
0683-2745	R: fxd, comp, 270 K ohms 5%, 1/4 w	01121	CB 2745	6
0683-3025	R: fxd, comp, 3000 ohms 5%, 1/4 w	01121	CB 3025	1
0683-3335	R: fxd, comp, 33 K ohms 5%, 1/4 w	01121	CB 3335	5
0683-3345	R: fxd, comp, 330 K ohms 5%, 1/4 w	01121	CB 3345	1
0683-3615	R: fxd, comp, 360 ohms 5%, 1/4 w	01121	CB 3615	1
0683-3625	R: fxd, comp, 3600 ohms 5%, 1/4 w	01121	CB 3625	1
0683-3925	R: fxd, comp, 3900 ohms 5%, 1/4 w	01121	CB 3925	38
0683-3935	R: fxd, comp, 39 K ohms, 1/4 w	01121	CB 3935	4
0683-3945	R: fxd, comp, 390 K ohms 5%, 1/4 w	01121	CB 3945	18
0683-4335	R: fxd, comp, 43 K ohms 5%, 1/4 w	01121	CB 4335	38
0683-4705	R: fxd, comp, 47 ohms 5%, 1/4 w	01121	CB 4705	1
0683-4725	R: fxd, comp, 4700 ohms 5%	01121	CB 4725	10
0683-4735	R: fxd, comp, 47 K ohms 5%, 1/4 w	01121	CB 4735	27
0683-4745	R: fxd, comp, 470 K ohms, 1/4 w	01121	CB 4745	2

See introduction to this section

Table 6-2. Replaceable Parts (cont'd)

Stock No.	Description	Mfr.	Mfr. Part No.	TQ
0683-5125	R: fxd, comp, 5100 ohms 5%, 1/4 w	01121	CB 5125	1
0683-5135	R: fxd, comp, 51 K ohms 5%, 1/4 w	01121	CB 5135	2
0683-5615	R: fxd, comp, 560 ohms 5%, 1/4 w	01121	CB 5615	1
0683-5625	R: fxd, comp, 5600 ohms 5%, 1/4 w	01121	CB 5625	5
0683-5635	R: fxd, comp, 56 K ohms 5%, 1/4 w	01121	CB 5635	41
0683-5645	R: fxd, comp, 560 K ohms 5%, 1/4 w	01121	CB 5645	1
0683-6235	R: fxd, comp, 63 K ohms 5%, 1/4 w	01121	CB 6235	1
0683-6825	R: fxd, comp, 6800 ohms 5%, 1/4 w	01121	CB 6825	7
0683-6835	R: fxd, comp, 68 K ohms 5%, 1/4 w	01121	CB 6835	13
0683-7525	R: fxd, comp, 7500 ohms 5%, 1/4 w	01121	CB 7525	6
0683-8225	R: fxd, comp, 8200 ohms 5%, 1/4 w	01121	CB 8225	8
0683-8235	R: fxd, comp, 82 K ohms 5%, 1/4 w	01121	CB 8235	2
0686-2725	R: fxd, comp, 2700 ohms 5%, 1/2 w	01121	EB 2725	1
0686-4725	R: fxd, comp, 4700 ohms 5%, 1/2 w	01121	EB 4725	1
0686-4735	R: fxd, comp, 47 K ohms 5%, 1/2 w	01121	EB 4735	4
0686-7525	R: fxd, 7500 ohms 5%, 1/2 w	01121	EB 7525	32
0687-1221	R: fxd, comp, 1200 ohms 10%, 1/2 w	01121	EB 1521	2
0687-5621	R: fxd, comp, 5600 ohms 10%, 1/2 w	01121	EB 5621	1
0687-5661	R: fxd, comp, 56 M ohms 10%, 1/2 w	01121	EB 5661	1
0687-6831	R: fxd, comp, 68 K ohms 10%, 1/2 w	01121	EB 6831	1
0698-1835	R: fxd, comp, 18 K ohms 5%, 1 w	01121	GB 1835	2
0698-3123	R: fxd, depc, 3830 ohms 1%, 1/2 w	01121	EB 3121	1
0727-0122	R: fxd, depc, 2.51 K ohms 1%, 1/2 w	19701	DC 1/2 CR5	1
0727-0124	R: fxd, depc, 3000 ohms 1%, 1/2 w	19701	DC 1/2 CR5	1
0727-0168	R: fxd, depc, 15 K ohms 1%, 1/2 w	19701	DC 1/2 CR5	2
0727-0206	R: fxd, depc 98 K ohms 1%, 1/2 w	19701	DC 1/2 CR5	1
0727-0222	R: fxd, depc 214 K ohms 1%, 1/2 w	19701	DC 1/2 CR5	1
0727-0255	R: fxd, depc, 800 K ohms 1%, 1/2 w	19701	DC 1/2 AR5	1
0757-0190	R: fxd, met flm, 20 K ohms 1%, 1/2 w	75042	CEC T-O	3
0757-0191	R: fxd, met flm, 80.6 K ohms 1%, 1/4 w	75042	CEC T-O	2
0757-0192	R: fxd, met flm, 60.4 K ohms 1%, 1/2 w	75042	CEC T-O	2
0757-0193	R: fxd, met flm, 3.32 K ohms 1%, 1/2 w	75042	CEC T-O	1
0757-0194	R: fxd, met flm, 1.33 megohms 1%, 1/2 w	75042	CEC T-O	1
0757-0195	R: fxd, met flm, 348 K ohms 1%, 1/2 w	75042	CEC T-O	1
0757-0196	R: fxd, met flm, 6.19 K ohms 1%, 1/2 w	75042	CEC T-O	1
0757-0197	R: fxd, met flm, 1500 ohms 1%, 1/2 w	75042	CEC T-O	1
0757-0198	R: fxd, met flm, 100 ohms 1%, 1/2 w	75042	CEC T-O	1
0758-0002	R: fxd, met flm, 560 ohms 5%, 1/2 w	07115	C 20	1
0758-0004	R: fxd, met flm, 2700 ohms 5%, 1/2 w	07115	C 20	1
0758-0024	R: fxd, met flm, 100 ohms 5%, 1/2 w	07115	C 20	1
0761-0026	R: fxd, met ox flm, 220 ohms 5%	07115	C32	1
0811-0139	R: fxd, ww, 4.5 megohms 0.01%, 1/2 w	05347	510A	2
0811-0140	R: fxd, ww, 895 K ohms 0.01%, 1/4 w	05347	510A	1
0811-0141	R: fxd, ww, 99.55 K ohms 0.01%, 1/4 w	05347	510A	1
0811-0142	R: fxd, ww, 200 K ohms, 1/4 w	05347	510A	1
0811-0143	R: fxd, ww, 7700 ohms 0.5%, 1/4 w	05347	510A	1
0811-0144	R: fxd, ww, 25 K ohms 0.2%, 1/4 w	05347	205A	1
0811-0145	R: fxd, ww, 2150 ohms 0.2%, 1/4 w	07088	EP-21	1
0813-0019	R: fxd, ww, 0.47 ohms 10%, 1/2 w	75042	BNH	1
0845-0001	Network: resistive	28480	0845-0001	5

See introduction to this section

Table 6-2. Replaceable Parts (cont'd)

Stock No.	Description	Mfr.	Mfr. Part No.	TQ
0905-0043	Gasket: Photoconductor	99538	obd#	5
0905-0051	Light Mask: Felt	78471	obd#	5
1000-0017	Window: Polaroid	47904	obd#	1
1200-0044	Socket: Transistor	97464	M7 (PB)	1
1200-0081	Insulator: Bushing	28480	1200-0081	2
1200-0091	Insulator: Transistor Anodized Aluminum	76530	294457	1
1251-0085	Connector: Female, 36-pin minat	02660	57-40360 (375)	1
1251-0087	Connector: Female, 50-pin minat	02660	57-4057-40500 (375)	1
1251-0131	Connector: Socket, Female, 1-pin	00373	69026-1164 (red)	1
1251-0135	Connector: Printed Circuit, 15-pin	02660	143-015-08 (109)	5
1251-0148	Connector: Power	60427	H-1061 1G-3L	1
1251-0208	Connector: Printed Circuit, 22-pin	000XX	SD-622UR	1
1251-0324	Connector: Test jack, male (red)	00373	69026-1064	1
1251-0394	Connector: Socket, Female, 50-pin	00373	69022-1164 (black)	1
1400-0084	Fuseholder extractor, post type	75915	342014	2
1410-0094	Bushing: Panel	28480	1410-0094	1
1450-0049	Indicator: Glow-lamp, neon	28480	1450-0049	1
1490-0030	Stand: tilt	28480	1490-0030	1
1510-0008	Binding Post Ass'y: red	28480	1510-0008	2
1510-0009	Binding Post Ass'y: black	28480	1510-0009	3
1820-0001	Semicon Device: transistor-diode	28480	1820-0001	1
1850-0040	Transistor: germanium, PNP	94154	2N383	3
1850-0062	Transistor: germanium	28480	1850-0062	58
1850-0096	Transistor: germanium, 2N2189, PNP	01295	2N2189	1
1850-0098	Transistor: germanium, PNP, selected	28480	1850-0098	1
1850-0103	Transistor: germanium, 2N2190, PNP	28480	1850-0103	1
1851-0017	Transistor: 2N1304	28480	1851-0017	4
1851-0024	Transistor: germanium, 2N388A, NPN	0000T	28388A	1
1853-0001	Transistor: silicon, 30 V, 900 mv, PNP	28480	1853-0001	1
1853-0009	Transistor: PNP	28480	1853-0009	1
1854-0003	Transistor: silicon, NPN	28480	1854-0003	1
1854-0022	Transistor: silicon, NPN	28480	1854-0022	2
1854-0029	Transistor: silicon, NPN	28480	1854-0029	1
1901-0025	Semicon Device: diode, junction	28480	1901-0025	53
1901-0026	Semicon Device: diode, junction, 1N3253	28480	1901-0026	4
1901-0029	Diode: silicon, piv, 600 v, 1N3255	28480	1901-0029	4
1901-0033	Semicon Device: diode, 1N485B	07910	1N85B	9
1901-0040	Semicon Device: diode, silicon	28480	1901-0040	1
1901-0052	Semicon Device: diode, pair, selected	28480	1901-0052	1
1901-0053	Semicon Device: diode, junction	28480	1901-0053	2
1901-0054	Semicon Device: diode, silicon	28480	1901-0054	1
1901-0171	Semicon Device: diode, pair, selected	28480	1901-0171	1
1902-0031	Semicon Device: diode, avalanche	28480	1902-0031	1
1902-0048	Semicon Device: diode, breakdown	28480	1902-0048	1
1902-0071	Semicon Device: diode, silicon	28480	1902-0071	1
1910-0015	Semicon Device: diode, germanium	73293	HD-1409	21
1910-0016	Semicon Device: diode, germanium	93332	D2361	1

See introduction to this section

Table 6-2. Replaceable Parts (cont'd)

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	
1970-0009	Display tube: neon, 10-digit	83594	85092	4	
1970-0012	Display tube: neon, ±	28480	1970-0012	1	
1990-0009	Plate: photoconductor matrix	28480	1990-0009	4	
1990-0010	Plate: photoconductor matrix	28480	1990-0010	1	
2100-0238	R: var, 250 ohms 20%, lin, 1/4 w	28480	2100-0238	1	
2100-0239	R: var, ww, 2000 ohms 20%, lin, 1-1/4 w	28480	2100-0239	1	
2100-0324	R: var, ww, 500 ohms 10%, lin, 1/4 w	28480	2100-0324	1	
2100-0354	R: var, ww, 1000 ohms 10%, lin, 2 w	28480	2100-0354	1	
2100-0392	R: var, ww, lin, 2 K ohms 10%, 0.25 w	28480	2100-0392	1	
2100-0436	R: var, comp, 200 ohms, lin 20%, 1/2 w	28480	2100-0436	1	
2100-0438	R: var, 250 K ohms, w/spst switch	28480	2100-0438	1	
2100-0439	R: var, ww, 250 ohms, lin 20%, 1/4 w	28480	2100-0439	1	
2100-0451	R: var, ww, 10 K ohms 10%, 2 w	28480	2100-0451	1	
2110-0016	Fuse: cartridge, 0.6 amp, slo-blo	75915	313.600	1	
2110-0033	Fuse: 0.75 amp, 250 v	75915	F02GH750A	1	
2140-0015	Lamp: glow, neon, NE-2H	24455	NE-2H	4	
2140-0028	Lamp: glow, frosted, neon, NE-2E	24455	NE-2E	3	
3101-0033	Switch: slide, 115/230 v	28480	3101-0033	1	
3101-0053	Switch: pushbutton, SPDT	28480	3101-0053	1	
5000-0732	Cover: rear, side, full module	28480	5000-0732	1	
5000-0733	Cover: front, side, full module	28480	5000-0733	1	
5060-0625	Binding Post Ass'y: left hand link	28480	5060-0625	1	
5060-0739	Assembly: top cover	28480	5060-0739	1	
5060-0751	Assembly: bottom cover, full module	28480	5060-0751	1	
5060-0763	Handle Ass'y: side	28480	5060-0763	2	
5060-0766	Retainer: 5H Handle Ass'y	28480	5060-0766	2	
5060-0767	Foot Ass'y: FM	28480	5060-0767	1	
8120-0078	Cable Power SVT-18-3, 7.5 feet	70903	KH4147	1	
9100-0182	Transformer: power	28480	9100-0182	1	
9140-0118	Coil: fxd, 500 μh, 5%	99800	2500-14	1	
9211-0248	Carton: shipping	84324	obd#	1	
9223-0040	Foam: polyethylene "post pak"	28480	9223-0040	1	
03440-00201	Panel: front	28480	03440-00201	1	
03440-00202	Panel: rear	28480	03440-00202	1	
03440-01201	Bracket: P. C. Board	28480	03440-01201	1	
03440-01202	Bar: readout	28480	03440-01202	1	
03440-01203	Bracket: DCV	28480	03440-01203	1	
03440-01204	Bar: support	28480	03440-01204	1	
03440-01205	Bracket: connector	28480	03440-01205	1	
03440-24701	Support: readout	28480	03440-24701	1	
03440-24702	Bar: retainer	28480	03440-24702	1	
03440-48301	Guide: plug-in	28480	03440-48301	2	
03440-48302	Insert: units readout	28480	03440-48302	1	
03440-48303	Bezel: window	28480	03440-48303	1	
03440-48304	Readout: units	28480	03440-48304	1	
03440-48305	Support: readout	28480	03440-48305	1	
03440-66501	Board Ass'y: Power Supply and Oscillator	28480	03440-66501	1	
03440-66503	Board Ass'y: Comparator	28480	03440-66503	1	
03440-66505	Board Ass'y: Decimal	28480	03440-66505	1	

See introduction to this section

Table 6-2. Replaceable Parts (cont'd)

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	
03440-66506	Board Ass'y: Function	28480	03440-66506	1	
03440-66507	Board Ass'y: Display and Ramp	28480	03440-66507	1	
03440-67501	Board Ass'y: Attenuator	28480	03440-66501	1	
03440-69501	Exciter: Photoconductor, Polarity	28480	03440-69501	1	
03440-69502	Photoconductor: Polarity	28480	03440-69502	1	
03440-82601	R: fxd, ww, 3 section	28480	03440-82601	1	
03440-84401	Kit: Accessory	28480	03440-84401	1	
05212-6010	Exciter: Photocell	28480	05212-6009	4	
05212-6011	Matrix Ass'y: Photoconductor	28480	05212-6011	4	
5212A-83C	Cover: Photoconductor	28480	5212A-83C	5	
5212L-4A	Counter Ass'y: Decade	28480	5212L-4A	4	
5212L-83C	Socket: Digit Display Tube	28480	5212L-83C	5	
03440-90001	Operating and Service Manual	28480	03440-90001		

See introduction to this section

APPENDIXCODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00090	U.S.A. Common	Any supplier of U.S.	07149	Filmco Corp.	New York, N. Y.	49956	Raytheon Company	Lexington, Mass.	74970	E.F. Johnson Co.	Waseca, Minn.
00136	McCoy Electronics	Mount Holly Springs, Pa.	07233	Cinch-Graphix Co.	City of Industry, Calif.	52090	Rowan Controller Co.	Baltimore, Md.	75042	International Resistance Co.	Philadelphia, Pa.
00171	Sage Electronics Corp.	Rochester, N. Y.	07261	Avnet Corp.	Los Angeles, Calif.	63743	Ward Leonard Electric	Mt. Vernon, N. Y.	75173	Jones, Howard B., Division	Chicago, Ill.
00334	Humdist Co.	Colton, Calif.	07263	Fairchild Semiconductor Corp.	Mountain View, Calif.	54294	Shallcross Mfg. Co.	Selma, N.C.	75378	James Knights Co.	Sandwich, Ill.
00335	Westlec Corp.	New York, N. Y.	07322	Minnesota Rubber Co.	Minneapolis, Minn.	55026	Simpson Electric Co.	Chicago, Ill.	75382	Kulka Electric Corporation	Mt. Vernon, N. Y.
00373	Garrick Packing Co.,	Camden, N. J.	07387	The Birtcher Corp.	Los Angeles, Calif.	55933	Sonotone Corp.	Emsford, N. Y.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.
00656	Aerovox Corp.	New Bedford, Mass.	07703	Technical Wire Products	Springfield, N.J.	55938	Sorenson & Co., Inc.	So. Norwalk, Conn.	75915	Littell Inc.	Des Plaines, Ill.
00779	Asp, Inc.	Harrisburg, Pa.	07910	Continental Device Corp.	Hawthorne, Calif.	56137	Spaulding Fibre Co., Inc.	Tonawanda, N. Y.	76005	Lord Mfg. Co.	Erie, Pa.
00801	Aircraft Radio Corp.	Bonton, N. J.	07933	Rheem Semiconductor Corp.	Mountain View, Calif.	56293	Sprague Electric Co.	North Adams, Mass.	76210	C.W. Harwood	San Francisco, Calif.
00810	Northern Engineering Laboratories, Inc.	Burlington, Wis.	07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.	58446	Telco, Inc.	St. Paul, Minn.	76433	Micamold Electronic Mfg. Corp.	Brooklyn, N. Y.
00852	Sangamo Electric Company,		07980	Boonton Radio Corp.	Boonton, N. J.	59376	Thomas & Betts Co.	Elizabeth 1, N. J.	76483	James Miller Mfg. Co., Inc.	Malden, Mass.
	Drift Division (Capacitors)	Marion, Ill.	08145	U.S. Engineering Co.	Los Angeles, Calif.	60741	Tripplett Electrical Inc.	Bluffton, Ohio	76493	J.W. Miller Co.	Los Angeles, Calif.
00866	Goe Engineering Co.	Los Angeles, Calif.	08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.	61775	Union Switch and Signal, Div. of	Swissvale, Pa.	76530	Monadnock Mills	San Leandro, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.				62119	Universal Electric Co.	Owosso, Mich.	76545	Mueller Electric Co.	Cleveland, Ohio
01121	Allen Bradley Co.	Milwaukee, Wis.	08717	Sloan Company	Burbank, Calif.	63743	Ward-Leonard Electric Co.	Mt. Vernon, N. Y.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.
01255	Litton Industries, Inc.	Beverly Hills, Calif.	08718	Cannos Electric Co. Phoenix Div.	Phoenix, Ariz.	64959	Western Electric Co., Inc.	New York, N. Y.	77068	Bendix Pacific Division of	No. Hollywood, Calif.
01261	TRW Semiconductors, Inc.	Lawndale, Calif.	08792	CBS Electronics Semiconductor Operations, Div. of C. B. S., Inc.	Lowell, Mass.	65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N. J.	77075	Pacific Metals Co.	San Francisco, Calif.
01295	Texas Instruments, Inc.	Dallas, Texas	08894	Mel-Rain	Indianapolis, Ind.	66295	Wittek Manufacturing Co.	Chicago 23, Ill.	77251	Phasstron Instrument and	South Pasadena, Calif.
	Transistor Products Div.		09026	Babcock Relays, Inc.	Costa Mesa, Calif.	66346	Wittek Optical Co.	Rochester, N. Y.	77252	Electronic Co.	Chicago, Ill.
01349	The Alliance Mfg. Co.	Alliance, Ohio	09134	Altech Electronics	Houston, Texas	70276	Allen Control Co., Inc.	Hartford, Conn.			
01361	Chassi-Trak Corp.	Indianapolis, Ind.	09145	Altech Electronics	San Jose, Calif.	70309	Allied Control Co., Inc.	New York, N. Y.			
01589	Pacific Relays, Inc.	Van Nuys, Calif.	09250	Electro Assemblies, Inc.	Chicago, Ill.	70319	Almetal Screw Prod. Co., Inc.	Garden City, N. Y.			
01930	Aerovox Corp.	Rockford, Ill.	09569	Mallory Battery Co. of	Toronto, Ontario, Canada	70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	73742	Potter and Blumfield, Div. of American	Princeton, Ind.
01961	Pulse Engineering Co.	Santa Clara, Calif.	09664	The Bristol Co.	Waterbury, Conn.	70561	Amperite Co., Inc.	New York, N. Y.		Machine and Foundry	Cincinnati, Ind.
02114	Ferrocube Corp. of America	Saugerties, N. Y.	10214	General Transistor Western Corp.	Los Angeles, Calif.	70563	Belden Mfg. Co.	Chicago, Ill.	73760	Radio Condenser Corp.	Camden, N. J.
02286	Cole Mfg. Co.	Palo Alto, Calif.				70998	Bird Electronic Corp.	Cleveland, Ohio	73763	Radio Receptor Co., Inc.	Brooklyn, N. Y.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.	10411	Ti-Tal, Inc.	Berkeley, Calif.	71002	Birnbach Radio Co.	New York, N. Y.	77764	Resistance Products, Inc.	Harrisburg, Pa.
02735	Radio Corp. of America, Semiconductor	Somerville, N. J.	10446	Carborundum Co.	Niagara Falls, N. Y.	71041	Boston Gear Works Div. of		77969	Rubercraft Corp. of Calif.	Torrance, Calif.
	Materials Div.		11236	CTS of Berne, Inc.	Berne, Ind.	71218	Bud Radio Inc.	Cleveland, Ohio	78189	Shakeproof Division of Illinois	Quincy, Mass.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.	11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.	71286	Canloc Fastener Corp.	Paramus, N. J.		Tool Works	Eigin, Ill.
02771	Hughes Engineering Co.	San Fernando, Calif.				71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.	78283	Signal Indicator Corp.	New York, N. Y.
03358	G.E. Semiconductor Products Dept. Syracuse, N. Y.		11312	Microwave Electronics Corp.	Palo Alto, Calif.	71400	Bussman Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.	78290	Struthers-Dunn Inc.	Pittman, N. J.
03389	Acme Machine & Tool Co.	Dayton, Ohio	11534	Duncan Electronic, Inc.	Santa Ana, Calif.	71436	Chicago Condenser Corp.	Chicago, Ill.	78452	Thompson-Bremer & Co.	Chicago, Ill.
03790	Eidena Corp.	El Monte, Calif.	11711	General Instrument Corporation	Newark, N. J.	71450	CTS Corp.	Chicago, Ill.	78471	Tilley Mfg. Co.	San Francisco, Calif.
03871	Transistor Electronic Corp.	Wakefield, Mass.		Semiconductor Division	Newark, N. J.	71459	CTS Corp.	Chicago, Ill.	78488	Stackpole Carbon Co.	St. Marys, Pa.
03888	Pylonite Resistor Co.	Marlton, N. J.	11717	Imperial Electronic, Inc.	Buena Park, Calif.	71459	CTS Corp.	Chicago, Ill.	78493	Standard Thomson Corp.	Waltham, Mass.
03954	Av Marine Motors, Inc.	Los Angeles, Calif.	11870	Malaba, Inc.	Palo Alto, Calif.	71459	CTS Corp.	Chicago, Ill.	78553	Timmerman Products, Inc.	Cleveland, Ohio
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.	11870	Malaba, Inc.	Dover, N. H.	71471	Canon Electric Co.	Los Angeles, Calif.	78750	Transformer Engineers	Pasadena, Calif.
04062	Elmenco Products Co.	New York, N. Y.	12259	Hippon Electric Co., Ltd.	Tokyo, Japan	71482	C.P. Clare & Co.	Chicago, Ill.	78947	Uconite Co.	Newtownville, Mass.
04272	H-Q Division of Aerovox	Myrtle Beach, S. C.	12590	Delta Semiconductor Inc.	Newport Beach, Calif.	71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.	79142	Vander Root, Inc.	Hartford, Conn.
04298	Eigen National Watch Co.,		13103	Thermoflex	Dallas, Texas				79251	Wenco Mfg. Co.	Chicago, Ill.
	Electronics Division	Burbank, Calif.	13396	Telefunken (G. M. B. H.)	Hannover, Germany	71700	The Danish Wire Co.	New York, N. Y.	79272	Winfield-Witt Electronics Corp.	Philadelphia, Pa.
04434	Dynac Division of Hewlett-Packard Co.	Palo Alto, Calif.	13835	Midland Mfg. Co.	Kansas City, Kansas	71744	Chicago Miniature Lamp Works	Chicago, Ill.	79963	Zierick Mfg. Corp.	New Rochelle, N. Y.
04451	Sylvania Electric Prods., Inc.	Mountain View, Calif.	14099	Sem-Tech	Newbury Park, Calif.	71753	A.O. Smith Corp., Crowley Div.	West Orange, N. J.	80031	Meeco Division of Sessions	Clark Co.
04473	Malvota, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	14193	Calif. Resistor Corp.	Santa Monica, Calif.	71785	Cinch Mfg. Corp.	Chicago, Ill.	80120	Schmitzer Alloy Products	Elizabethtown, N. J.
04732	Fulton Co., Inc., Western Div.	Calver City, Calif.	14298	American Components, Inc.	Conshohocken, Pa.	71984	Dow Corning Corp.	Midland, Mich.	80130	Times Facsimile Corp.	New York, N. Y.
04773	Automatic Electric Co.	Northlake, Ill.	14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N. J.	72092	Eitel-McCollough, Inc.	San Bruno, Calif.	80131	Electronic Industries Association.	Any brand
04777	Automatic Electric Sales Corp.	Northlake, Ill.	14660	Williams Mfg. Co.	San Jose, Calif.	72136	Electro Mative Mfg. Co., Inc.	Wilmington, Conn.		tube meeting EIA standards	Washington, D. C.
04796	Seasun Wire & Cable Co.	Redwood City, Calif.	15999	The Daven Co.	Liverington, N. J.	71707	Coto Coll. Co., Inc.	Providence, R. I.	80207	Unimax Switch, Div. of	Wallingford, Conn.
04810	Precision Coil Spring Co.	El Monte, Calif.	16037	Spence Pine Mfg. Co.	Spencer, Mass.	72534	John E. Fast & Co.	Chicago, Ill.	80223	United Transformer Corp.	New York, N. Y.
04830	P. M. Motor Company	Chicago 44, Ill.	16352	Computer Diode Corp.	Los Angeles, Calif.	72619	Omni-Cor	Brooklyn, N. Y.	80248	Oxford Electric Corp.	Chicago, Ill.
05000	Twentieth Century Plastics, Inc.	Los Angeles, Calif.	16688	De Jur-Amsco Corporation	Long Island City 1, N. Y.	72656	General Ceramics Corp.	Keasbey, N. J.	80294	Bourns Laboratories, Inc.	Riverside, Calif.
			16758	Belco Radio Div. of G. H. Corp.	Kokomo, Ind.	72659	General Instrument Corp., Semiconductor Div.	Newark, N. J.	80411	Acro Div. of Robertshaw	Fulton Controls Co.
05277	Westinghouse Electric Corp.,		16873	E. I. DuPont and Co., Inc.	Wilmington, Del.	72758	Girard-Hopkins	Oakland, Calif.	80486	AH Star Products Inc.	Columbus 16, Ohio
	Semiconductor Dept.	Youngwood, Pa.	19315	Eclipse Pioneer, Div. of	Teterboro, N. J.	72765	Drake Mfg. Co.	Chicago, Ill.	80509	Avery Adhesive Label Corp.	Monrovia, Calif.
05347	Ultravox, Inc.	San Mateo, Calif.	19500	Thomas A. Edison Industries,	West Orange, N. J.	72825	Hugh H. Eby Inc.	Philadelphia, Pa.	80583	Hammerlund Co., Inc.	New York, N. Y.
05593	Huachuata Engineering Co.	Sunnyvale, Calif.	19701	Electro Manufacturing Co.	Kansas City, Mo.	72928	Gudeman Co.	Chicago, Ill.	80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
05624	Borber Colman Co.	Rockford, Ill.	20183	Electronic Tube Corp.	Philadelphia, Pa.	72964	Robert M. Hadley Co.	Los Angeles, Calif.	81030	International Instruments, Inc.	New Haven, Conn.
05728	Tilfen Optical Co.	Roslyn Heights, Long Island, N. Y.	21226	Executive, Inc.	New York, N. Y.	72982	Erie Resistor Corp.	Erie, Pa.	81073	Grayhill Co.	LaGrange, Ill.
			21529	Fanstel Metallurgical Corp.	No. Chicago, Ill.	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.	81095	Triad Transformer Corp.	Venice, Calif.
05729	Metropolitan Telecommunications Corp.	Brooklyn, N. Y.	21335	The Fafnir Bearing Co.	New Britain, Conn.	73075	H.M. Harper Co.	Chicago, Ill.	81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
05783	Steward Engineering Co.	Santa Cruz, Calif.	21944	Fad. Telephone and Radio Corp.	Clifton, N. J.	73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.	81349	Military Specification	
05820	Waketfield Engineering Inc.	Waketfield, Mass.	24446	General Electric Co.	Schenectady, N. Y.	73293	Hughes Products Division of	Newport Beach, Calif.	81415	Witkor Products, Inc.	Cleveland, Ohio
06004	The Basicall Corp.	Bridgeport, Conn.	24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio	73445	Amperite Electronic Co., Div. of	Hicksville, N. Y.	81453	Raytheon Mfg. Co., Industrial Components	Newtown, Mass.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.	24655	General Radio Co.	West Concord, Mass.	73490	American Philips Co., Inc.	So. Pasadena, Calif.	81483	International Rectifier Corp.	El Segundo, Calif.
06402	E. T. A. Products Co. of America	Chicago, Ill.	26365	Gries Reproducer Corp.	New Rochelle, N. Y.	73506	Beckman Helipot Corp.	Hamden, Conn.	81541	The Airpak Products Co.	Cambridge, Mass.
06540	Amtron Electronic		26462	Grobel Frie Co. of America, Inc.	Carlsbad, N. J.	73559	Bradley Semiconductor Corp.	Hartford, Conn.	81860	Barry Controls, Inc.	Watertown, Mass.
	Hardware Co. Inc.	New Rochelle, N. Y.	26992	Hamilton Watch Co.	Lancaster, Pa.	73582	George K. Garrett Co., Inc.	Philadelphia, Pa.	82042	Carler Parts Co.	Skokie, Ill.
06559	Beede Electrical Instrument Co., Inc.		31173	G.E. Receiving Tube Dept.	Owensboro, Ky.	73734	Fischer Special Mfg. Co.	Cincinnati, Ohio	82142	Jeffers Electronics Division of	Du Bois, Pa.
		Pensacook, N. H.	35434	Lection Inc.	Chicago, Ill.	73743	Fischer Special Mfg. Co.	Elkhart, Ind.		Speer Carbon Co.	
06751	U. S. Sensor Division of Nuclear Corp.	Phoenix, Arizona	36195	Stoway Corp.	Hawkesbury, Ontario, Canada	73793	The General Industries Co.	Elkhart, Ind.	82170	Allen B. DuMont Labs, Inc.	Clifton, N. J.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.	37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.	73846	Gushen Stamping & Tool Co.	Brooklyn, N. Y.	82209	Maguire Industries, Inc.	Greenwich, Conn.
07115	Coring Glass Works		39543	Mechanical Industries Prod. Co.	Akron, Ohio	73899	JFD Electronics Corp.	San Jose, Calif.	82219	Sylvania Electric Prod. Inc.	Emporium, Pa.
	Electronic Components Dept.	Bradford, Pa.	40920	Miniature Precision Bearings, Inc.	Keene, N. H.	73905	Jennings Radio Mfg. Co.	Nesque, N. J.		Electronic Tube Div.	
07126	Digital Co.	Pasadena, Calif.	42199	Muter Co.	Chicago, Ill.	74276	Signalite Inc.	Winchester, Mass.	82389	Switchcraft, Inc.	East Newark, N. J.
07137	Transistor Electronics Corp.	Minneapolis, Minn.	43990	C.A. Morgan Co.	Englewood, Colo.	74455	J.H. Wines, and Sons	Chicago, Ill.	82647	Metals and Controls, Inc., Div. of	
07138	Westinghouse Electric Co.		44655	Onvite Mfg. Co.	Shokio, Ill.	74851	R.F. Products Division of Amphenol	Danbury, Conn.		Spencer Prods.	Attleboro, Mass.
	Electronic Tube Div.	Elmira, N. Y.	47904	Polaroid Corp.	Cambridge, Mass.	74868	Borg Electronics Corp.				
			48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.						

APPENDIX **CODE LIST OF MANUFACTURERS (Sheet 2 of 2)**

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
82866	Research Products Corp.	Madison, Wis.	89636	Carter Parts Div. of Economy Sales Co.	Chicago, Ill.	95263	Leecraft Mfg. Co., Inc.	New York, N.Y.	THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.		
82877	Robins Manufacturing Co., Inc.	Woodstock, N.Y.	89665	United Transformer Co.	Chicago, Ill.	95264	Lerc Electronics, Inc.	Burbank, Calif.			
82893	Vector Electronic Co.	Glendale, Calif.	90179	U. S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.	95265	National Coil Co.	Burbank, Calif.			
83053	Western Washer Mfr. Co.	Los Angeles, Calif.	90970	Bearing Engineering Co.	San Francisco, Calif.	95275	Vibramon, Inc.	Bridgeport, Conn.			
83058	Carr Fastener Co.	Cambridge, Mass.	91260	Canter Spring Mfg. Co.	San Francisco, Calif.	95348	Gordas Corp.	Bloomfield, N.J.	00800	JFD Electronics Corp.	Van Nuys, Calif.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.	91345	Muller Dial & Nameplate Co.	El Monte, Calif.	95354	Methode Mfg. Co.	Chicago, Ill.	00806	Trexco Company	Mosman View, Calif.
83125	Pyramid Electric Co.	Darlington, S.C.	91418	Radio Materials Co.	Chicago, Ill.	95387	Wickless Co.	Sunnyvale, Calif.	00806	Western Devices, Inc.	Inglewood, Calif.
83148	Electro Cords Co.	Los Angeles, Calif.	91506	Augat Brothers', Inc.	Attleboro, Mass.	96067	Huggins Laboratories	Chicago, Ill.	00800	Winchester Electronics, Inc.	Santa Monica, Calif.
83186	Victory Engineering Corp.	Union, N.J.	91637	Dale Electronics, Inc.	Columbus, Nebr.	96095	Hi-Q Division of Aerovox	Clean, N.Y.	0080F	Malco Tool and Die	Los Angeles, Calif.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.	91662	Elco Corp.	Philadelphia, Pa.	96256	Thordarson-Meissner Div. of Magure Industries, Inc.	MI, Carmel, Ill.	0090M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
83315	Hubbell Corp.	Mundelein, Ill.	91737	Grenar Mfg. Co., Inc.	Wakefield, Mass.	96296	Solar Manufacturing Co.	Los Angeles, Calif.	0090N	Nahm-Bros. Spring Co.	San Leandro, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.	91827	K F Development Co.	Redwood City, Calif.	96330	Carlton Screw Co.	Chicago, Ill.	0090P	Ty-Car Mfg. Co., Inc.	Holiston, Mass.
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85471	A. B. Boyd Co.	San Francisco, Calif.	94137	General Cable Corp.	Bayonne, N.J.	98821	North Hills Electric Co.	Mineola, N.Y.	009WW	California Eastern Lab.	Burlingame, Calif.
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87664	Van Waters & Rogers Inc.	Seattle, Wash.	95236	Alfies Products Corp.	Miami, Fla.	99924	Renbrandt, Inc.	Boston, Mass.			
87930	Tower Mfg. Corp	Providence, R. I.	95238	Continental Connector Corp.	Woodside, N.Y.	99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.			
88140	Cutter-Hammer, Inc.	Lincoln, Ill.				99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.			
88229	Gould-National Batteries, Inc.	St. Paul, Minn.									
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MANUAL BACKDATING CHANGES

MODEL 3440A

DIGITAL VOLTMETER

Manual Serial Prefixed: 439-

Manual Printed: 10/64

To adapt this manual to instruments with other serial prefixes, make changes shown in tables.

NOTE

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the stock number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
435-	None	314-	1, 2
421-00925	1		
415-	1		
347-	1, 2		

CHANGE #1**Table of Replaceable Parts****Delete:**

A3R65	R: fxd, comp, 12 K ohms	0683-1235	1 each
A3R64	R: fxd, comp, 22 K ohms	0683-2235	1 each
A3R63	R: fxd, comp, 150 K ohms	0683-1545	1 each
A3Q18	Transistor: 2N2712	1854-0029	1 each
A3QCR1	Transistor - diode	1820-0001	1 each
A3CR15, 16	Diode: silicon	1901-0025	2 each

Add:

A3C4	C: fxd, .001 μ f	0150-0050	1 each
A3R15, 16	R: fxd, comp, 100 K ohms	0683-1045	2 each
A3Q14	Transistor: selected	1854-0003	1 each
A3CR2	Diode: silicon	1901-0025	1 each
A3CR12	Diode: avalanche	1902-0070	1 each

Display and Ramp Assembly A3

For replacement order  stock number 03440-66507. Display and Ramp Assembly A3,  stock number 03440-66507, is a direct replacement for  stock number 03440-66502. If during repair, it is found necessary to replace Display and Ramp Assembly,  stock number 03440-66507, is recommended because the DC coupled circuit insures a print command immediately after each range change, and the transistor-diode combination A3QCR1 reduces warm-up time.

Specifications, Table 1-1:

Change Print Command to AC coupled.

Figure 5-13:

Delete: Figure 5-13 in entirety.

Add: New Figure 5-13 as shown in Figure 1 on next page.

Manual Backdating Changes Model 3440A Page 2

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
435-	None	314-	1, 2
421-00925	1		
415-	1		
347-	1, 2		

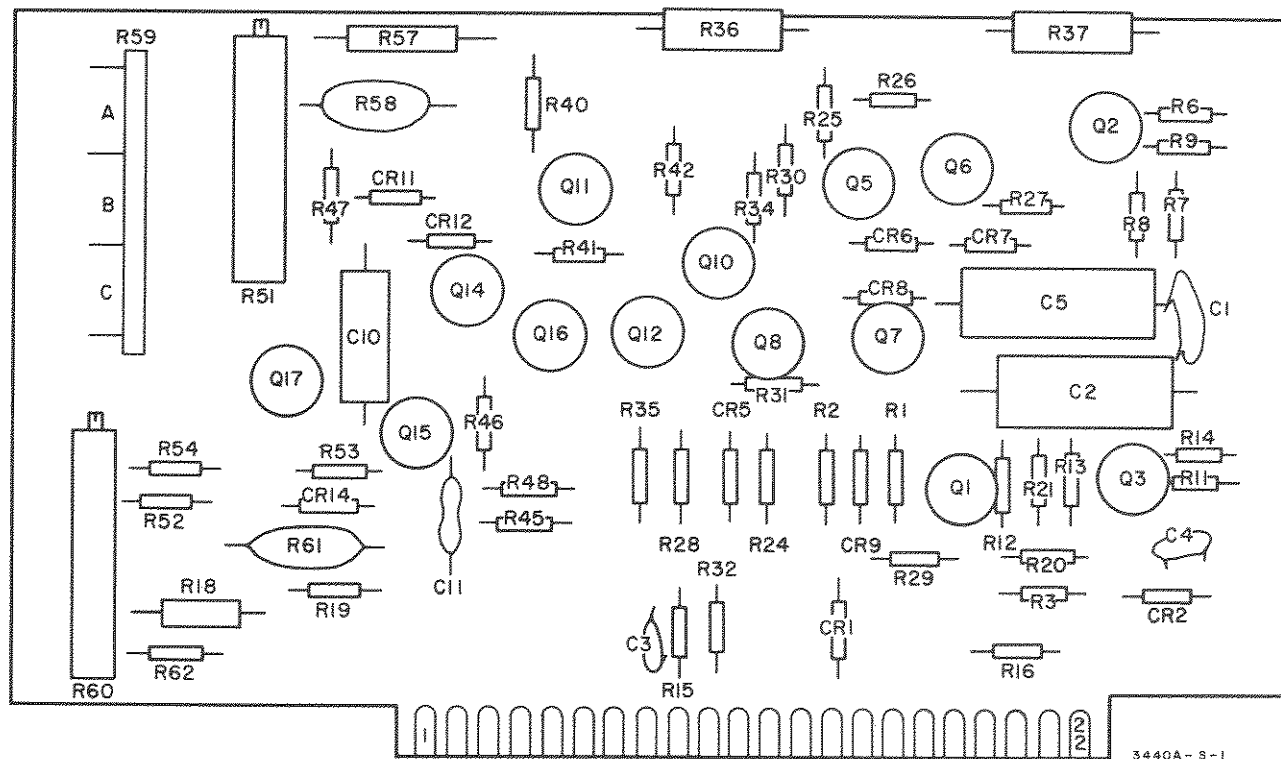


Figure 1

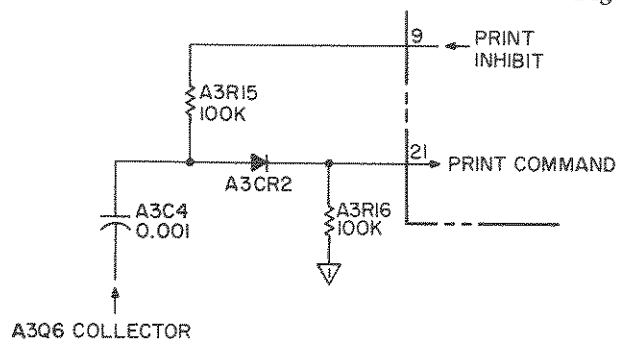


Figure 2

Figure 5-14. Delete: A3Q18,
A3R63 - 65, A3CR15, 16

Add: Print Command circuit as
shown above.

Change #2

See paragraph 5-54, DC Isolation.

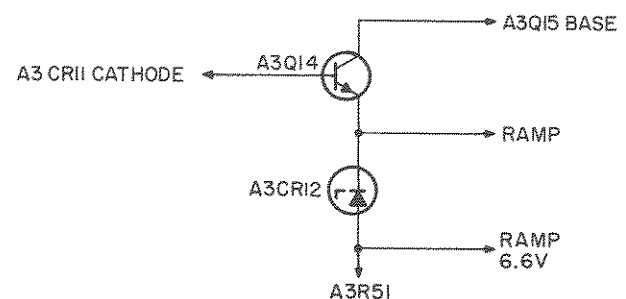


Figure 3

Delete: A3QCR1A, B

Add: A3Q14, A3CR12 as shown
above.



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SHIPPING

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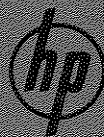
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Geneva, Switzerland
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Cable: "HEWPACKSA"





hp MANUAL CHANGES

MODEL 3440A

DIGITAL VOLTMETER

Manual Serial Prefixed: 439

Part No. 03440-90001

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

➤ New or revised item

Instrument Serial Prefix

Make Manual Changes

Instrument Serial Prefix

Make Manual Changes

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
ALL	ERRATA	541	1, 2, 3, 4
439-01651 and above	1		
439-01776 and above	1, 2		
439-02221 and above	1, 2, 3		

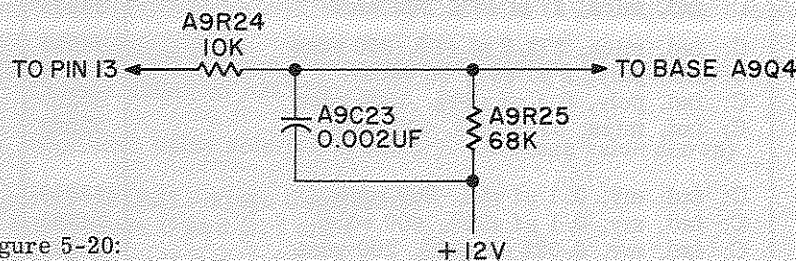
CHANGE #1

Figure 5-16 (A9), Oscillator and Section VI, Replaceable Parts:

Add the following:

A9C23, C: fxd, 0.002 μ f $\pm$ 20%, 1000 vdcw; Part No. 0150-0023;
Mfr. 56289; Mfr. Part No. 19C203A.

Partial schematic shows connections.



ERRATA

Figure 5-20:

Change +35 v to -35 v.

Section V, Figure 5-12:

A2R39: Change from 470 to 560.

Section V, Figure 5-14:

A3R63: Change from 450 K to 150 K.

Section VI, Table 6-2, Replaceable Parts:

Add the following:

Part No.	DESCRIPTION	MFR	MFR PART NO.	TQ
0130-0001	C: var, 7-45 pf 500 vdcw	72982	50300 D2P0-33R	1
0140-0172	C: fxd, mica, 0.003 μ f $\pm$ 1%, 100 vdcw	72136	DM19F302F	2
0140-0175	C: fxd, mica, 39 pf $\pm$ 2%, 300 vdcw	14655	CD15E390G	1
0140-0194	C: fxd, mica, 110 pf $\pm$ 5%, 300 vdcw	14655	CD15F111J	28
0140-0195	C: fxd, mica, 130 pf $\pm$ 5%, 300 vdcw	14655	RDM15F131J3C	1
0140-0196	C: fxd, mica, 150 pf $\pm$ 5%, 300 vdcw	14655	CD15F151J	2
0140-0198	C: fxd, mica, 200 pf $\pm$ 5%, 300 vdcw	14655	RDM15F201J3C	13
0140-0199	C: fxd, mica, 240 pf $\pm$ 5%, 300 vdcw	14655	RDM15F241J3C	4
0140-0200	C: fxd, mica, 398 pf $\pm$ 5%, 300 vdcw	14655	RDM15F391J3C	2

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ALL	ERRATA
439-01651 and above	1
439-01776 and above	1, 2
439-02226 and above	1, 2, 3

541	1, 2, 3, 4

ERRATA

④ PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ
0140-0208	C: fxd, mica, 680 pf $\pm 5\%$, 300 vdcw	14655	RDM15F681J3C	2
0140-0216	C: fxd, mica, 120 pf $\pm 2\%$, 300 vdcw	14655	RDM15F121G3C	1
0140-0217	C: fxd, mica, 140 pf $\pm 2\%$, 300 vdcw	14655	RDM15F141G3C	4
0140-0225	C: fxd, mica, 300 pf $\pm 1\%$, 300 vdcw	14655	RDM15F301F3C	1
0150-0012	C: fxd, cer, 0.01 μ f $\pm 20\%$, 1000 vdcw	71590	obd#	1
0150-0050	C: fxd, cer, 1000 pf, 600 vdcw	000RR	obd#	3
0150-0096	C: fxd, cer, 0.05 μ f, 100 vdcw	28480	0150-0096	1
0150-0098	C: fxd, cer, 0.01 μ f, 1000 vdcw	91418	obd#	1
0150-0121	C: fxd, cer, 0.1 μ f, 50 vdcw	56289	obd#	4
0160-0153	C: fxd, 0.001 μ f $\pm 10\%$	56289	192P10292	1
0160-0161	C: fxd, 0.01 μ f $\pm 10\%$, 200 vdcw	56289	192P10392	5
0160-0162	C: fxd, 0.022 μ f $\pm 10\%$	56289	192P22392	1
0160-0178	C: fxd, mica, 27 pf $\pm 5\%$, 300 vdcw	14655	CD15E270J	2
0160-0191	C: fxd, mica, 272.2 pf $\pm 1\%$, 300 vdcw	14655	CD19E(272PF)F	1
0160-0221	C: fxd, poly, 2 μ f $\pm 5\%$, 50 vdcw	56289	obd#	1
0160-0222	C: fxd, poly, 0.1 μ f $\pm 20\%$, 1000 vdcw	56289	obd#	1
0160-0223	C: fxd, mica, 33 pf $\pm 5\%$, 500 vdcw	72982	315,000, R3A0330 J	1
0170-0019	C: fxd, my, 0.1 μ f $\pm 5\%$, 200 vdcw	56289	192P10452	2
0170-0022	C: fxd, my, 0.1 μ f $\pm 20\%$, 600 vdcw	56289	148P175A	1
0170-0024	C: fxd, my, 0.022 μ f $\pm 20\%$, 200 vdcw	56289	192P22302A	1
0170-0055	C: fxd, my, 0.1 μ f $\pm 20\%$, 200 vdcw	56289	192P10402A	2
0170-0070	C: fxd, my, 0.22 μ f $\pm 20\%$, 50 vdcw	84411	obd#	2
0180-0039	C: fxd, elect, 100 μ f, 12 vdcw	56289	D32697	1
0180-0047	C: fxd, elect, 500 μ f, 75 vdcw	56289	D32443	1
0180-0091	C: fxd, elect, 10 μ f, 1000 vdcw	56289	30D106G100DD4	1
0684-1001	R: fxd, comp, 10 ohms $\pm 10\%$, 1/4 w	01121	CB1001	2
1251-1026	Connector, Socket, female, 50 pin	75173	57-20500-25	1
2100-0078	R: var, comp, 500 ohms $\pm 30\%$, lin, 0.3 w	11236	obd#	1
5060-0634	Binding post ass'y, red, 3/4" stud	28480	5060-0634	2
5060-0635	Binding post ass'y, blk, 3/4" stud	28480	5060-0635	3
03440-66504	Assy, polarity board	28480	03440-66504	1

Delete 1990-0009, Plate: photoconductor matrix and change total quantity for 1990-0010 to 5.

Title Page:

Add under Backdating Changes: 314-.

Table 1-1a, Specifications (Basic Unit):

Under Power approximately 20 watts to: 20 watts to 30 watts according to plug-in.

1-1b Response Time: delete "within".

1-1b Voltage Accuracy: Change "0°C to 50°C" to 0°C to 15°C and 40°C to 50°C.

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Note: Φ Part No. and Φ Stock No. are synonymous.

ERRATA

Proceed as follows when using the Model 3440A with a plug-in containing Φ Part No. 1251-1025 as the connector P6.

NOTE

This connector fits tighter than the previous connector.

INSTALLATION

Make certain the connector at the rear of the plug-in is properly matched and turn the locking screw completely to its clockwise position.

REMOVAL OF PLUG-IN

Turn the locking screw completely to its counterclockwise position, thus the spring is released and the plug-in is slightly pushed out of its compartment.

Change #2

Figure 5-12 (A2) Voltage Comparator and Section VI Replaceable Parts.
Change A2C17 to A2C17*

(Optimum value selected at factory. Average value shown)

ERRATA

Figure 5-12 (A2) Voltage Comparator
Interchange G and G; I and I

Figure 5-14 (A3) Ramp Generator
Interchange S and $\bar{S}$

Figure 5-16 (A4) Count Gate, Polarity, (A9) Oscillator
Interchange P and $\bar{P}$
Interchange R and $\bar{R}$
Interchange K and $\bar{K}$

Change #3

Section VI Replaceable Parts

Change A9Q6 from Φ Part No. 1850-0062 to Φ Part No. 1853-0016

Change A3Q18 from Φ Part No. 1854-0029 to Φ Part No. 1851-0017

Miscellaneous:

Change Handle Ass'y side to Φ Part No. 5060-0222

Change #4

Section VI Replaceable Parts

Add: A3C12 Capacitor fxd 680 pf $\pm 5\%$ 500 vdcw Φ Part No. 0140-0208

► Change: A3R30 to -hp- Part No. 0757-0451 R: fxd met flm 24.3 K ohms $\pm 1\%$
1/8 w

► Change: A3R31 to -hp- Part No. 0757-0444 R: fxd met flm 12.1 K ohms $\pm 1\%$ 1/8 w

► Figure 5-14 (A3) Ramp Generator

Change R30 to 24.3 K ohm, R31 to 12.1 K ohm.

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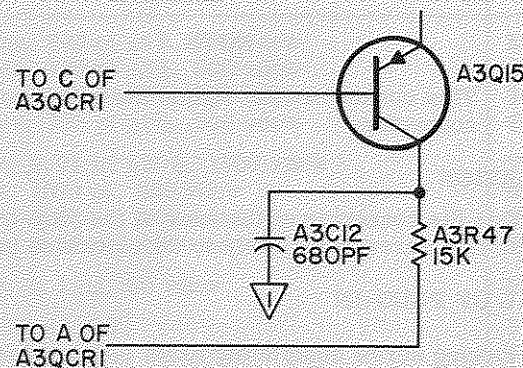
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Note: ϕ Part No. and ϕ Stock No. are synonymous.

Change #4 (Cont'd)

Figure 5-14. (A3) Ramp Generator

Add: A3C12 as shown in the following partial schematic:



ERRATA

Table of Contents Page ii

Change Pages 4-3 to 4-1

Page iii List of Illustrations

Change 4-10 to Lamp Control

Table 1-1a Specifications

Add to: Available Plug-in Units

3445A AC/DC Range Unit

Paragraph 3-6

Change Figure 3-2 to Figure 3-1

Paragraph 3-13

Change mating connector to -hp- Part No. 1251-0086

Change Figure 5-21 to 5-22

Paragraph 4-44

Change "Change Restorer" to Charge Restorer"

Paragraph 5-17 e 2

Change Figure 5-13 to Figure 5-11

Paragraph 5-16 d

Change ± 40 cps to ± 400 cps

Table 4-2 Explanation of Logic Symbology, Flip-flop

Change "input" to "output" in the sentence "A true input will cause the OUTPUT directly across to go true."